1/2 point CDT documented scientific credit. See Page 36.

By Dani Farago, RDT
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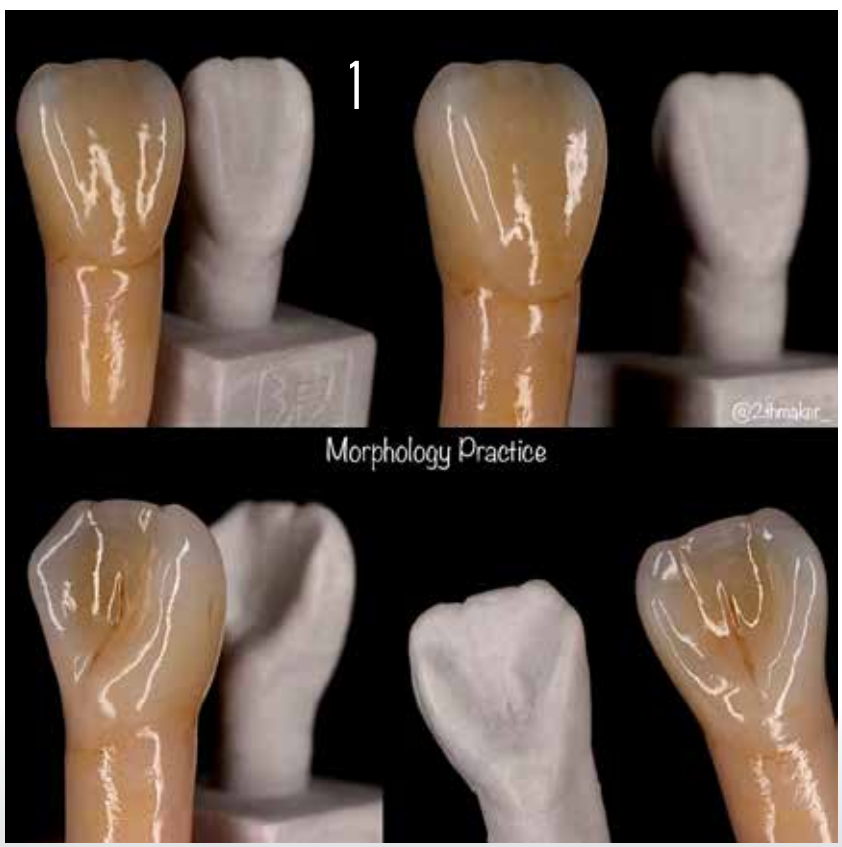
The Finer Details of Dental Ceramics

Learning the art of dental ceramics has always been (and probably always will be) an intimidating task, especially for absolute beginners. Hands-on courses are usually taught by master technicians and are intended for intermediate-advanced students who are heavily involved in the industry. These types of classes are great for gaining experience and expanding knowledge, but although inspiring, the techniques are complex and can be overwhelming for a new student. While interesting in theory, the information shared is usually hard to integrate into everyday practice, unless you manage or own a lab that specializes in high-end anterior esthetics.



When I first started taking continuing education courses, I was completely stunned by the sheer amount of information that was shared within those few, short days. The tips and tricks shared between masters at these courses are valuable to your growth as a technician and the experience is both enjoyable and humbling. I was fortunate enough to learn from some of the best porcelain technicians in the industry, and had the opportunity to study their techniques up close and in person. I asked endless questions, trying to find what made them a ceramic guru in the first place, as if there was some secret to their skill that I just hadn't grasped yet. Each time, I was faced with the same conclusion: ***"just keep practicing."***

This is a reality that, although frustrating to realize at the time, I now wholeheartedly accept and understand. The more I practiced, the more mistakes I made, and the more mistakes I made, the more problems I had to find solutions for. Going to a course with the goal of answering your existing questions, rather than just for the sake of general education, will undoubtedly unlock your full learning potential.

The beauty of dental technology is that there is a lifetime of studying involved. Knowing your porcelain, observing morphology (**Fig. 1**), using the right tools,

correctly color matching, and troubleshooting commonly occurring issues are what differentiate an average technician from an excellent one. When it comes to anterior esthetics, experimentation and consistency are key and there are a few basic subjects that every novice ceramist should learn when beginning their porcelain education journey.

Studying these topics will impact your work in a major way and will help you better understand the content that is being taught at advanced courses. Much of the knowledge discussed in this article is a mixture of advice that has been passed down to me from highly respected porcelain technicians and my own personal experience. This material is not new, but is often overlooked or considered "common sense" when in reality, these finer details are crucial components to fabricating a successful restoration and maintaining high-end, consistent results.

After all, practice makes progress (**Fig. 2**).

The point of this article is to guide a beginner technician onto the right path to improve their work, expand their understanding and enhance their overall learning potential, using a simple build-up technique that can be integrated into their everyday workflow.

"An investment in knowledge pays the best interest."
– Benjamin Franklin

1. Symmetry

A smile will look more naturally appealing if there is harmony and symmetry between the restoration and the surrounding teeth. Nature is chaotic, so perfect symmetry between existing dentition is not necessary but optical illusions are often utilized to produce esthetically pleasing results.

For example, making the mesial thirds of the central incisors symmetrical would be ideal, as that portion is most noticeable when a person smiles. To make the restoration more lifelike, the distals can be made to look asymmetrical, in both length and shape.

Mimicking the distance between line angles and lobes is another way to create symmetry and is especially helpful to know when tasked in making teeth with varying widths look balanced and proportionate to each other.

Tip Mirrors are great for examining symmetry, so keeping one at your workbench is beneficial. Place the restoration on the model and hold it at mouth level facing the mirror, simulating how the patient will see themselves when looking at their own reflection. Checking the restoration from a different point of view can help you see any imperfections that may not be visible to you when looking straight at the patient.

Perspective is everything.

2. Texture

Texture plays an important part in light reflection and refraction (**Fig. 3**).

Nature is unpredictable, a fact that is important to remember when creating micro-texture and surface characterization such as pits, grooves, fissures and perikymata. There are no straight lines in nature, so texture should be trimmed in at various sizes and depths using different bur shapes. Macro-texture makes up the overall form, including the marginal ridges and line angles.

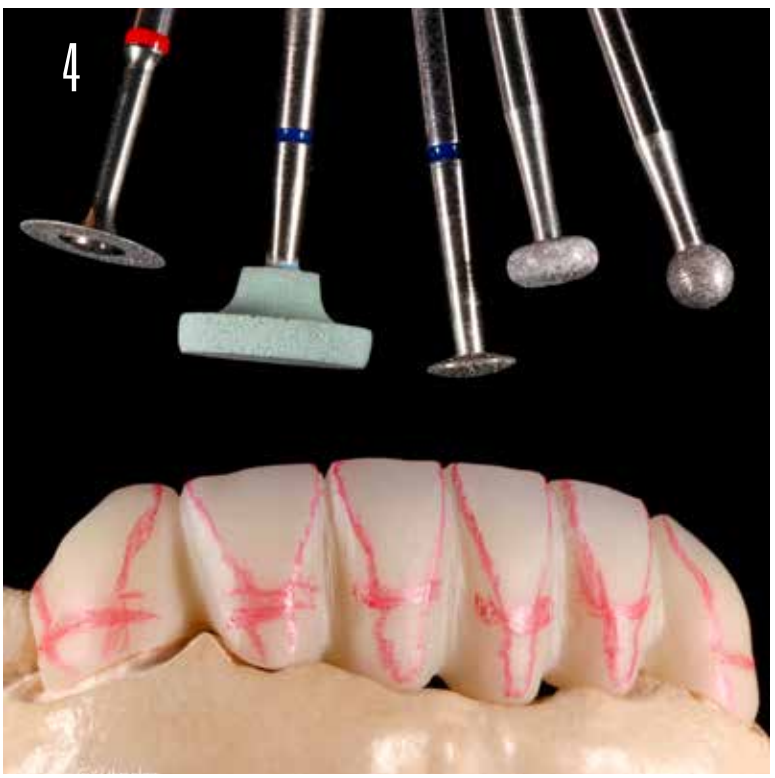
Texture shows organic wear, which is always present in natural dentition, and eliminates the fake, glass-like surface that over-glazed and under-contoured crowns otherwise produce.

Tip Perikymata looks most natural when done with a sharp, pointed bur and under magnification. When trimming, vibrate your hand to create curvy, wavelike, uneven lines across the facial surface, focusing on the developmental grooves and being careful to leave convexities such as lobes and line angles untouched.

3. Anatomy and Morphology

These terms are often used interchangeably when they are completely different and play their own, integral part in the creation of a natural looking restoration.

Morphology is the study of forms and how they relate to each other whereas anatomy is the study of the form's internal structure. In other words, morphology studies the container and anatomy studies the contents within the container. In dentistry, morphology refers to the size, shape and form of the tooth and anatomy refers to the internal details found inside the tooth, such as dentin, enamel, pulp, nerves, and blood vessels.



Tip Subtractive techniques, such as carving gypsum and trimming porcelain, are great exercises when learning morphology. Collecting models of natural dentition and studying organic tooth structure will train your mind's eye to notice microscopic detail, which then directly translates into the overall quality of your work.

4. Light and Shadows

Both light and shadow play a huge role in the successful fabrication of dental restorations. A natural tooth is three-dimensional so form, symmetry, texture, and morphology are all best observed under various lighting situations and when held at several different angles. Shadowy areas will show concavities and lit up areas will show convexities.

Tip Keep a small desk lamp at your bench. Place the restoration on the model and hold it right up to the light. Rotate the model in several different directions, observing how the light changes as it hits each of the tooth's surfaces. Observing and mimicking the surface's relationship to light will greatly improve the esthetics of the final restoration.

5. Reflection and Refraction

The basic rule here is that the more texture a surface has, the more irregular reflective properties it possesses. Light bounces off a shiny surface and reflects the wave of light back at the same angle, whereas translucent surfaces absorb light into the object, penetrating deep into its core, and altering the hue and value of the restoration.

In "*regular reflection*" light hits a smooth, polished surface and reflects toward the original source in a singular direction. In "*irregular reflection*" light hits a bumpy surface and reflects the light back at the same angle but in several different directions.

Texture will play a major role on how the restoration reflects and refracts light, as well as the final hue and value of the crown. Irregular light reflection will add a natural surface luster that smooth, untextured and over-glazed surfaces cannot produce.

Tip Use different burs to help produce a naturally uneven surface. Manufacturers make burs in assorted shapes, sizes, lengths, and abrasiveness for a reason; use the variety to your advantage (**Fig. 4**)!

6. Shade Selection

When choosing a final color, make sure to use at least three different shade tabs, placing them side by side and positioning the incisal third of the selected shades with the incisal edge of the patient's teeth. Angle the guides at a slight, upwards angle to eliminate any overexposure and distortion of color that your camera's flash or overhead lights may cause.

Many aspects can skew your perception of color.

That is why it is standard practice to choose an approximate shade, based on its hue and value, and then place a different shade on either side, for contrasting purposes (**Fig. 5**). Later, when observing the photos on your phone or computer, you can choose an appropriate color based on comparison.

Tip In any simple editing app, you can layer a black and white filter onto the picture (**Fig. 6**). This technique will eliminate the color, instantly revealing the brightness value of the patient's surrounding dentition and will help you determine which of the shade tabs to choose to produce a restoration that blends seamlessly intraorally. Incorrect value is often the cause of unfortunate looking esthetics.

Chroma can easily be custom adjusted with either porcelain or staining techniques later, but the restoration's brightness level is much more difficult to fix.

7. Substructure Choice

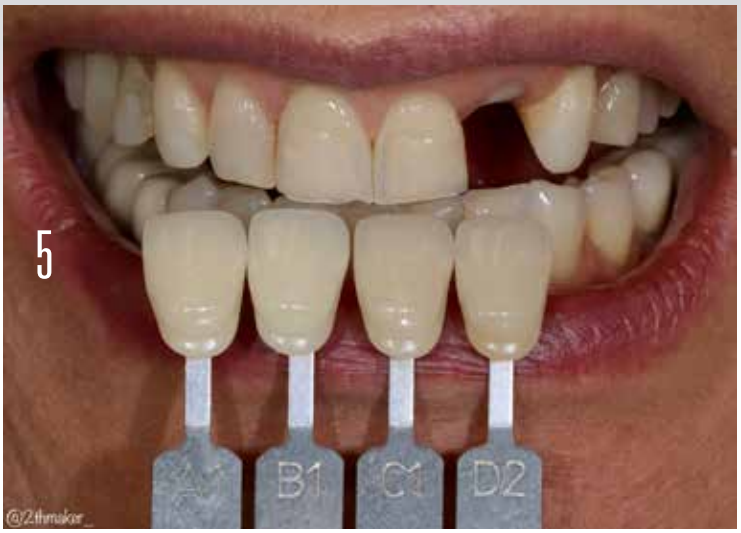
Lithium disilicate has always been the most esthetic option on the market, considering it is an all-porcelain alternative, with a potential for highly translucent results when compared to its zirconia counterpart, as well as better bonding properties. With the advances made in dental technology within the last few years, however, zirconia has become a staple in the digital dentistry workflow. It is essential to consider each material's contraindications when choosing a substructure, taking into account the durability and esthetic properties of each material.

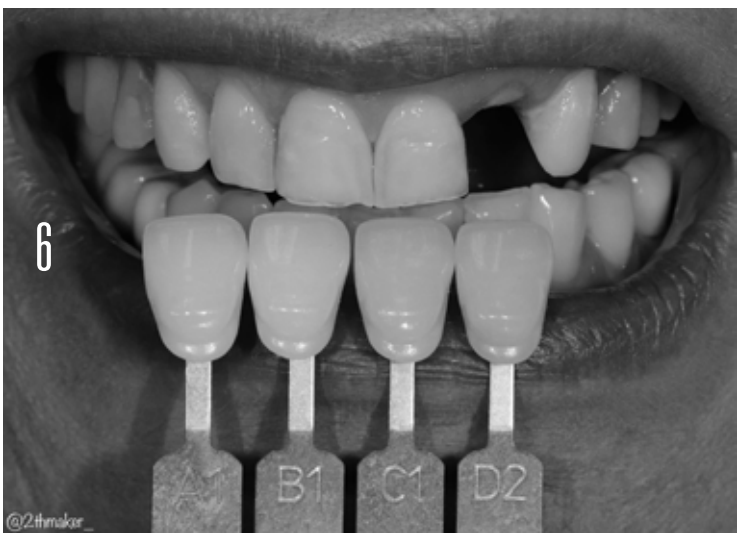
Tip Although generally more opaque, zirconia is a stronger substructure option when compared to lithium disilicate, making full contour or cutback zirconia restorations an ideal choice when the patient has a heavy bite, severe malocclusion or if they excessively and habitually grind their teeth. Lithium disilicate is a great choice for veneers, thanks to its higher esthetic potential and superior bonding properties.

8. Surface Luster

Finally, surface luster should be taken into consideration. A highly glazed crown has an artificial sheen to it, often described as "glassy" or "pearlescent." Natural teeth are matte, and saliva is what makes teeth look shiny. If the restoration is heavily glazed, the addition of saliva will make it stand out in comparison to the surrounding dentition.

Tip A surface with various intensities of glaze would give the final restoration a more natural luster. The prominent areas are usually heavily worn and should be smoother and more light reflective, whereas the lesser worn concave areas should have a matte finish. The differences in shine give the restoration a more multi-dimensional, natural look.



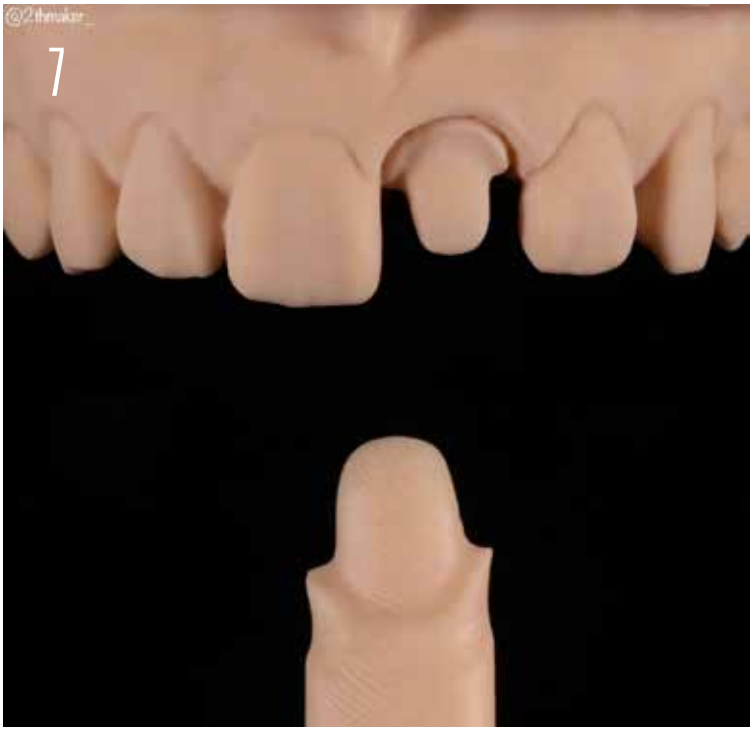


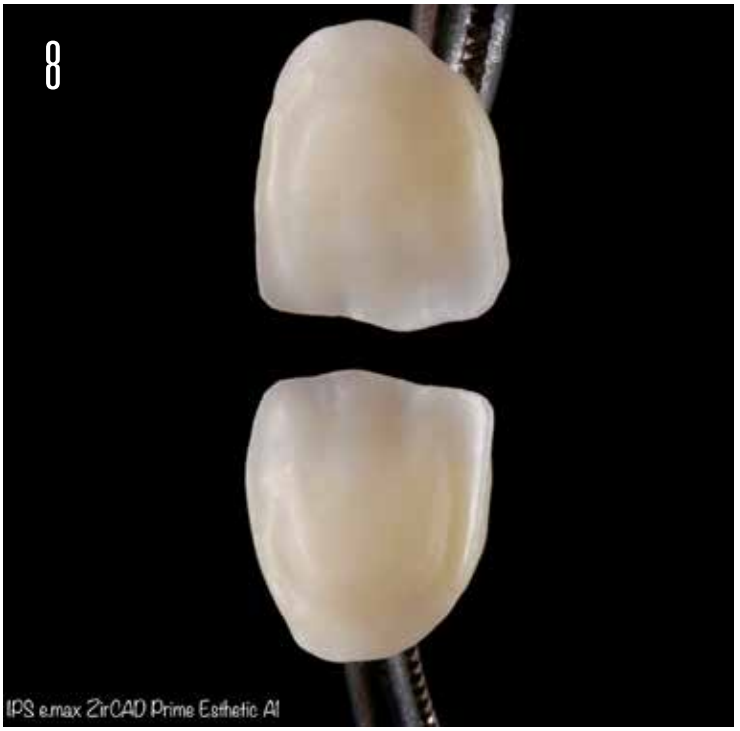
Porcelain Layering Cutback Technique

Keeping the above considerations in mind, you can now move on to layering porcelain.

The results shown here are achieved on a cutback zirconia restoration. This can be done by digitally designing a crown to full contour and then reducing from the facial surface, making sure to create a deeper indent in the area right beneath the incisal edge. This will allow adequate depth for internal details, such as mamelons and translucent porcelains.

I will exclusively be using materials manufactured by Ivoclar for this sample project, since it is my preferred brand to work with. IPS e.max ZirCAD Prime Esthetic zirconia was chosen for this study and the facial surface was porcelain stacked using IPS e.max Ceram. Any staining, whether internal or external, was done using IPS Ivocolor. With that being said, the instructions given for this simple, beginner-friendly build-up technique will still apply. Regardless of the products you choose to work with, the concept remains the same.





Instructions

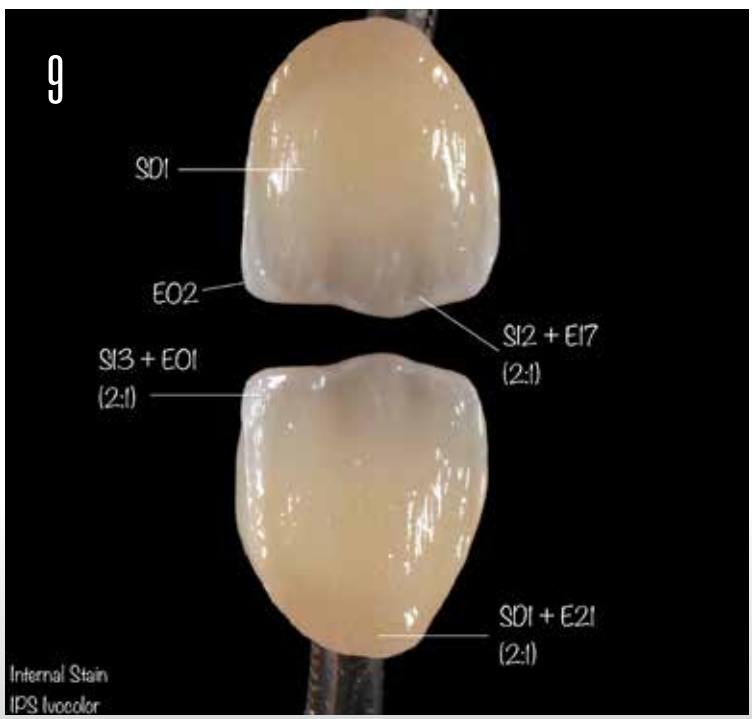
1. Always begin by analyzing the case. This includes the model, die and prep (**Fig. 7**), as well as the zirconia restoration that has been provided (**Fig. 8**). You must quality control the case every step of the way to ensure ideal fit and harmonious color are always present.

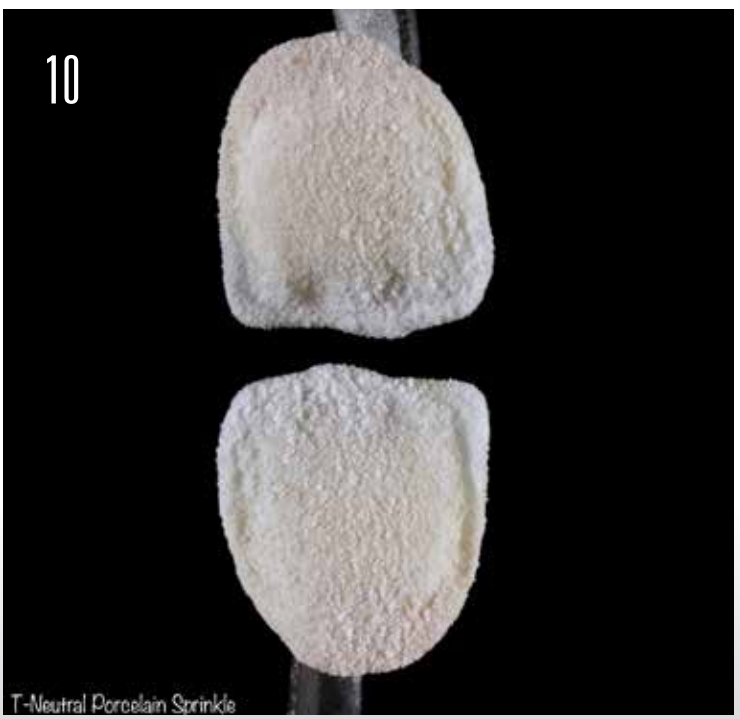
2. After quality control, move onto the wash bake. Apply a thin layer of glaze paste onto the porcelain bearing surfaces of the zirconia core and stain where needed. Usually, the chroma is enhanced at the gingival-third using the desired dentin shade, while a grey or violet stain is applied at the incisal-third, creating an illusion of depth (**Fig. 9**).

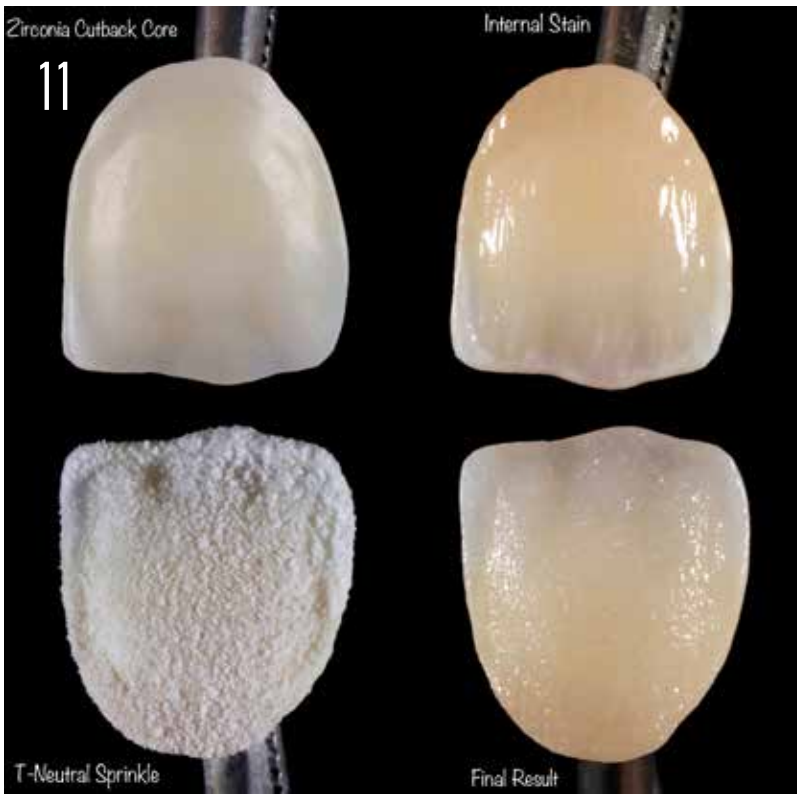
Tip For a higher value result, use a fluorescent glaze powder or paste.

Tip Mixing the dentin shade with a pink or red stain at a 3:1 ratio and applying to the gingival third of the restoration will make the tooth structure surrounding the gums appear warmer, without introducing undesirable yellow or orange hues.

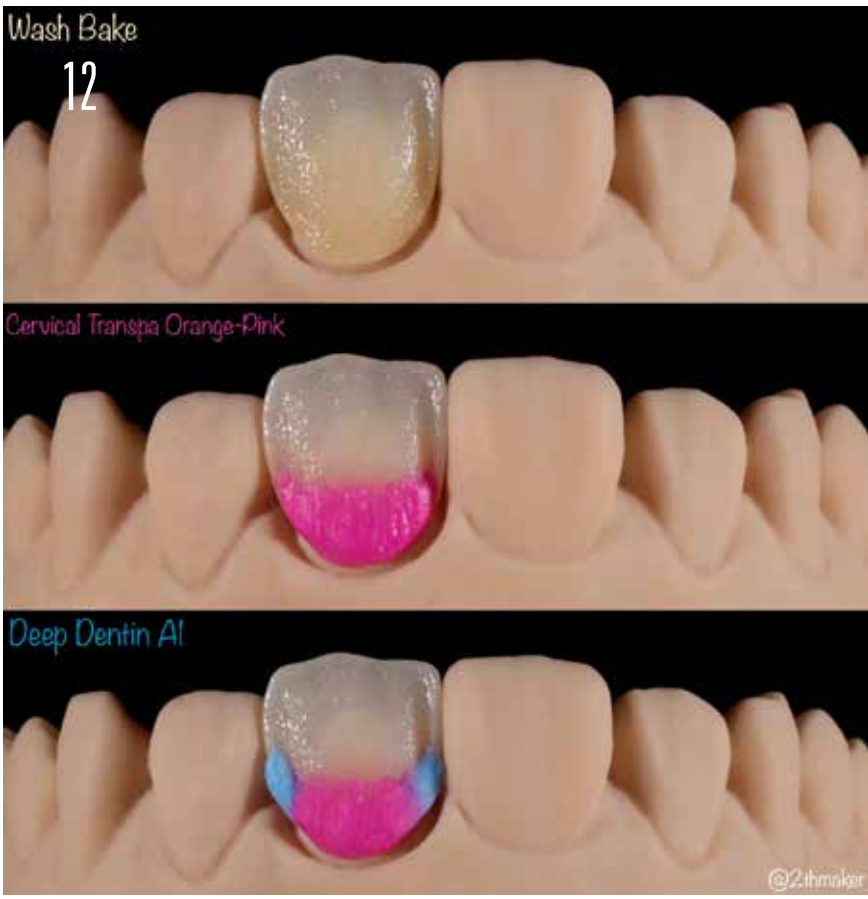
Using a fluffy brush, sprinkle *Transpa-Neutral* porcelain powder onto the wet surface, making sure to blow off excess ceramic (**Fig. 10**). "*T-N*" is a highly translucent material with a







neutral undertone. The purpose of this wash firing is to create a thin, even layer of porcelain with a micro-roughness that causes irregular light reflection and a better bond between the porcelain layers. For added hue, you can sprinkle a *Dentin* or a *Cervical-Transpa* shade instead. This small change will give the restoration additional chromatic value internally (**Fig. 11**).



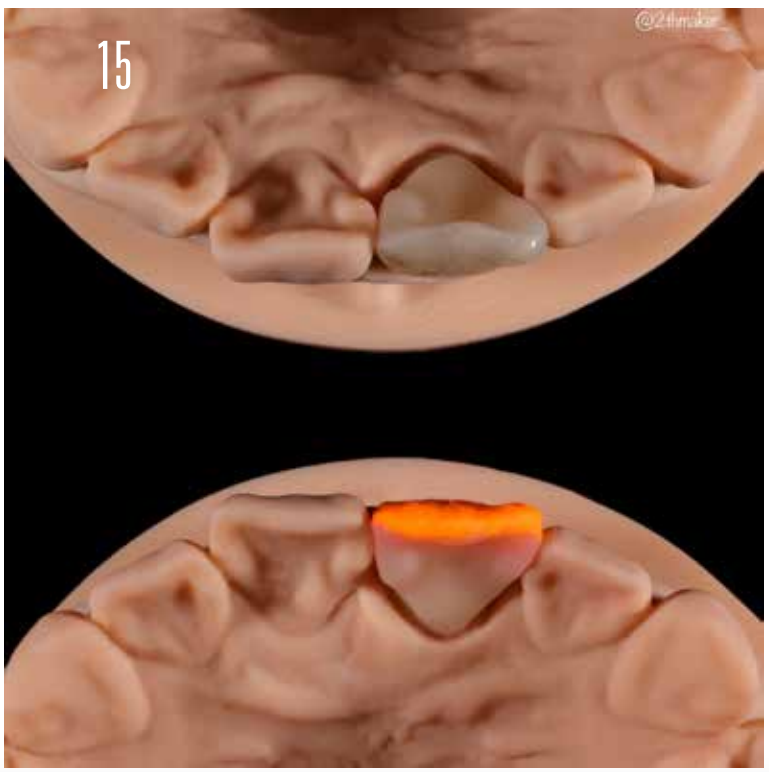
3. The first porcelain bake should be a thin application of chromatic ceramics. The shade of the zirconia core acts as the bulk of your dentin, so *Dentin* porcelain is often only necessary in small quantities and applied only where needed.

First, apply a mixture of the desired *Dentin* shade (in this case, A1) and *Cervical-Transpa Pink-Orange* at a ratio of 2:1 to the cervical area. "*CT-OP*" is a translucent material with a warm, pinkish hue. Mixing a small portion of this material with *Dentin* and applying at the gingival-third will allow for a harmonious color transition between the tissue and the clinical crown, creating a natural gradient effect.

Next, apply a layer of *Deep Dentin* (also known as opaque dentin) porcelain in the interproximal areas, near the gingiva. This allows for increased light reflection and prevents the presence of shadows, which often lowers the value of the restoration and causes a grey tone to reflect onto the gums (**Fig. 12**).

Working your way up the crown, apply the desired *Dentin* shade at the middle-third and feather the color upwards with the tip of your brush, blending the porcelain into the incisal area (**Fig. 13**).

In the incisal-third, place a 1:1 ratio of the *Dentin* shade mixed with *Transpa-Neutral*. The *Transpa-Neutral* powder helps to soften the chroma and adds a glassy, transparent element to the *Dentin*. Teeth are anything but monochromatic, so shade gradients produce a more natural result.



Build this bake to the desired length of the final restoration using the *Dentin/Transpa-Neutral* mixture. It is at this stage that a thin layer of porcelain at the incisal region is cut back with a thin blade, to make room for mamelons or other internal effects. For this case study, however, we are sticking to a simpler, more minimalistic layering technique (**Fig. 14**).

When assessing size and contour, make sure to view the incisal region from above (**Fig. 15**). Ensure that the incisal edge is lined up with the adjacent teeth. Adjusting bulk is simple but correcting misaligned morphology is time consuming and complicated.

Tip If this porcelain layer was stacked correctly, the restoration will not need to be trimmed after baking. Trimming dilutes the chroma intensity of the porcelain, so it's better to leave the bulk of the grinding process until the final shaping and contouring stage. If a bubble or debris is visible on the surface of the restoration after baking, it must be removed before the next porcelain layer application (**Fig. 16**).

4. The enamel bake's purpose is to introduce translucent material into the otherwise chromatic restoration.

When using this material, the desired translucency and value should be taken into consideration. Depending on the chosen color, translucency and desired end-result, enamel porcelain powders can be mixed at varying ratios.

For this specific crown, apply a mixture of Opal Effect 1 and Opal Effect 3 at a 2:1 ratio to the whole surface of the restoration. In the areas you want to keep a more intense hue, only apply Opal Effect 1, as it will allow more of the chromatic dentin layer to shine through.

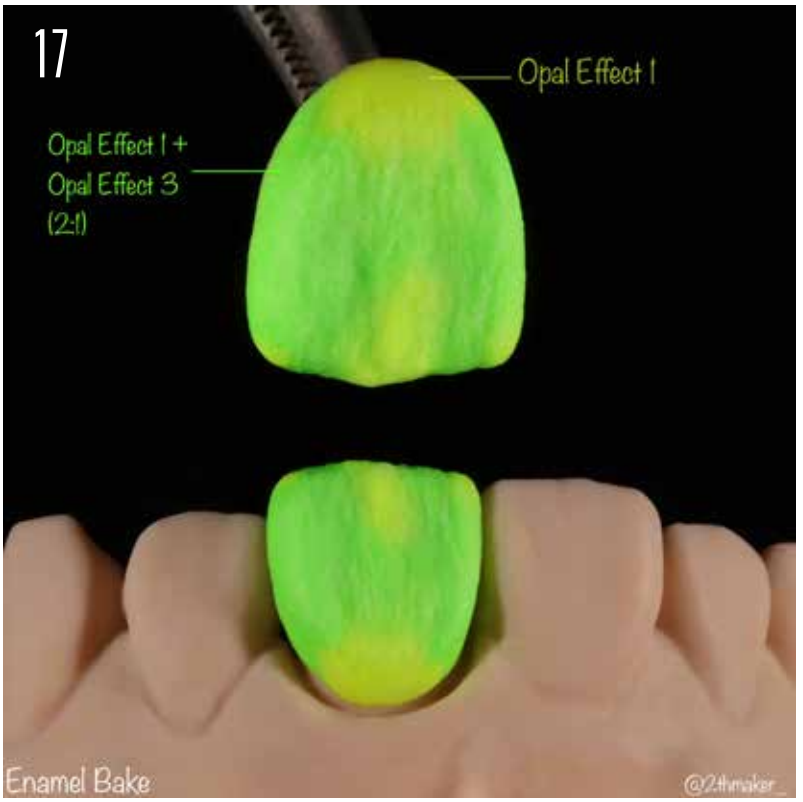
Many technicians hesitate at the thought of putting translucent ceramic material on the whole surface of the crown because it dilutes the color and seems like an unnecessary step. We are attempting to mimic nature, however, where enamel covers the whole surface of the clinical crown. This is one of the many techniques available to technicians, but not every restoration will require the use of this method, just as not every tooth still has all (or any) of their existing enamel remaining. In this case, we are building an ideal crown, as we would for a relatively young, healthy patient (**Fig. 17**).

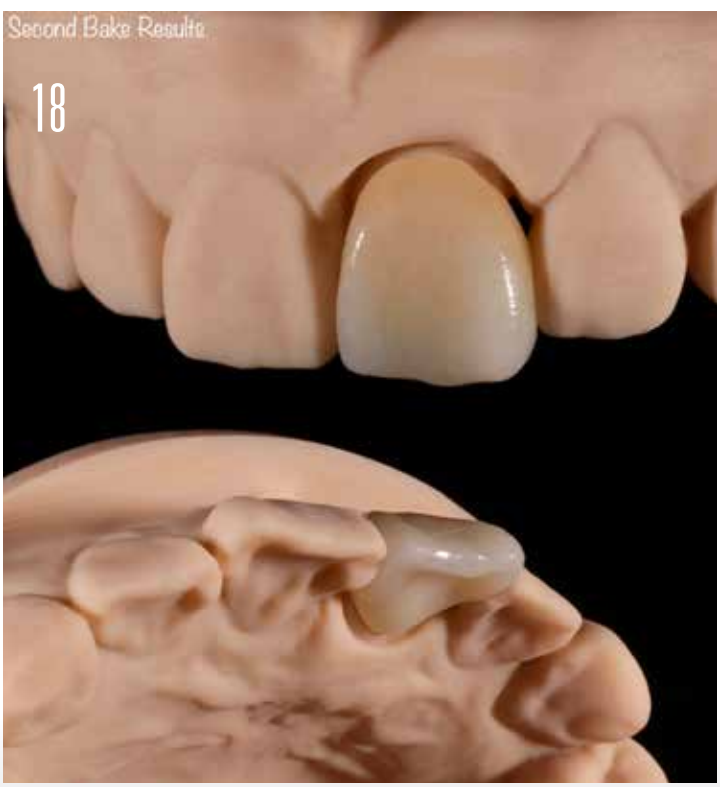
It is recommended to overbuild slightly, making the crown longer and bulkier than its neighboring teeth. Once that is achieved, remove it from the model and fill any empty space in the cervical and interproximal regions with their corresponding porcelain mixtures.

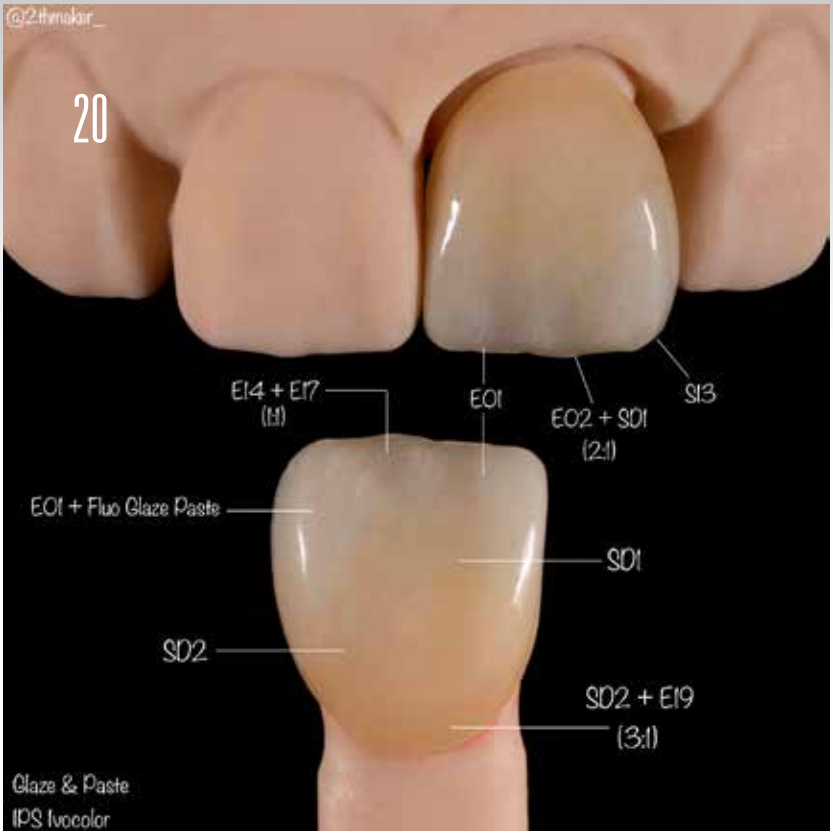
5. After the crown is baked, place it back on the model and access the color and form (**Fig. 18**). Correction bakes are often necessary and may require you to add missing details, such as incisal corners, marginal ridges, or contact areas. These small corrections can be done by mixing the ceramic with a glaze liquid, making the porcelain easier to manipulate, thanks to the thick and sticky nature of the liquid.

If the crown requires no further adjustments, trim and shape the restoration with diamond burs, disks, and rubber wheels. This is the time to shape, texturize, and add surface characterization, as well as establish lobes, create prominent ridges, and add perikymata (**Fig. 19**).

6. The stain and glaze stage requires separate bakes; one for stains, and one for glaze. If everything is done in one layer,







the stains have a higher risk of running and mixing, producing an undesirable color. One-bake applications where stain and glaze are applied simultaneously will also likely be streaky and will erode faster intraorally. The best practice is to apply stains sparingly and assess the result after each bake, making corrections along the way (**Fig. 20**).

When staining, keep the following tips in mind:

- Calcification spots are very common (especially on a young patient or when the patient had orthodontic treatments) and can be achieved by mixing equal parts glaze paste with white stain.
- Teeth are multi-colored and multi-dimensional. When applying stain, remember to keep gradation in mind. The gingival-third should always be more chromatic than the incisal-third.
- A "halo" effect on the incisal edge provides a very natural touch. Oftentimes, there is a strip of chroma, usually with either a vanilla, sandy or creamy-orange hue, right past the translucent, incisal edge. This gives the crown a slightly worn-in look.
- Be cautious when using blue shades! If you're heavy-handed, the blue can look aggressive and unnatural. This kind of hue is best achieved with porcelain, rather than stain. Grey and violet tones are a little softer and add a similar translucent effect.
- Adding more color in the interproximal region will create the illusion of a narrower restoration. This is especially recommended when creating bridges, since it helps individualize the teeth.
- Remember that stains are opaque. A restoration looks more natural and esthetic when the color comes from the porcelain. When too much stain is applied, it covers the depth and translucency that was built from ceramic (**Fig. 21**).

7. Once the stain and glaze stages are complete, assess the overall shine of the restoration's surface. The ridges and line angles should be smoother and more heavily reflective than the areas with a lot of micro-texture, especially around the developmental grooves. For concave areas needing a matte finish, use a rubber wheel that is specifically made for mattifying purposes. For areas needing a glossy finish, use a high-shine rubber wheel, finishing the restoration with polishing paste, if needed (**Fig. 22**).

Tip When making a surface either matte or polished, make sure to keep your handpiece at a low speed. Finishing a porcelain crown with rubber wheels should be a delicate process. Applying too much heat and pressure to the restoration can result in an unnatural sheen and the accidental removal of stains and surface texture.

Tip Tissue bearing surfaces prefer highly polished zirconia over glazed zirconia. Inadequate glazing procedures can result in micro-porosities and bacteria can stick to the rough exterior, so finishing the restoration by following polishing procedures is recommended.

And that's it! The restoration is now complete. This is a simple method; one that is relatively beginner-friendly but still produces high-end, esthetic results. As you progress in your porcelain stacking journey, you will learn various other practices that include mamelons, light blockers and absorbers, internal characterization and much more.

Regardless of the technique's difficulty or your level of expertise, putting passion behind your work is the best tool for growth.

In Conclusion

Dental technicians are a dedicated group of people. As artists, we pour our heart and soul into every case we complete, so when our work is rejected, it can feel very discouraging. Be kind to yourself and shift your mindset – ***every failure is a learning opportunity.***

As a beginner technician, making mistakes is the best thing you can do for your professional development. If you apply the lessons you learned, each new case will be better than the last. This goes back to the realization I made at the beginning of my own porcelain education: ***"just keep practicing."***

If I could add anything to this advice, it would be to keep your horse blinders on, stay focused on your goals and be consistent with your efforts. Growth is not linear, nor is it meant to be. Consistency, regardless of circumstances, is the key to success.

Honor your progress, because it is only through repetition, discipline, and sheer determination that your true potential will present itself.

"The expert at anything was once a beginner." – Helen Hayes

Figures 23-24 *feature intraoral pictures of crowns made with a similarly simple technique.*

About the Author

Dani Farago graduated from the dental technology program at George Brown College in 2017. She became a RDT the following year, is a second-generation dental technician, and works at her family-owned crown and bridge lab in Toronto, Ontario, Canada, where she specializes in esthetic and digital dentistry. Her goal is to become a master ceramist and to eventually host her own courses that focus on advanced porcelain techniques and dental photography. Dani's goal is to mimic the beauty of nature and she hones her skills by spending all of her free time in the lab. **JDT**

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