Chairside Correlation in CEREC 3D software

Correlation has been a popular design mode in the CEREC software since CEREC 2. This mode allows the user to “copy” an existing (or waxed up, etc) occlusion and have the milling unit produce that occlusion as the final milled result. Correlation can be an excellent way to minimize intra-oral adjustment of the final restoration.

How does Correlation work?

The user chooses “Correlation” as the design mode and then proceeds to take an Optical Impression of the pre-operative condition, followed by a post-operative Optical Impression. When these two pictures have been taken, the user clicks the green Forward arrow and the software matches the images together automatically.

Next the user Trims the neighbouring teeth and draws the Preparation Margin as usual. Clicking Forward after drawing of the Preparation Margin, the software then proposes an equator line (pink). This proposal should be manually edited by the user to copy the shape of the equator of the pre-operative condition. Re-draw the new equator to match the contour of the equator from the Occlusion model.

Clicking Forward the software proposes a Copy line. Everything inside this green line will be copied by the software.

Clicking Forward again shows the completed proposal. Check and modify proximal contacts as normal and verify the result in all views. Proceed to milling stage.

That is a simple, straight forward single unit Correlation case. Hungry for more? What is really going on here, and how can the user maximize their results with this powerful software?
Introduction: The Correlation Process

How exactly does the software match the images up? How can one be assured of getting a “successful Correlation” every time?

First, it would be helpful to understand what the software is doing when it is “Correlating”. After the user takes the pre-operative and post-operative images and clicks Forward, the software builds the Preparation model from the image(s) in the Preparation section of the Image Catalog. Then it builds the Occlusion model in the same way and goes through a number of steps in an attempt to get the Preparation model and the Occlusion model to “fit together”. If successful, the software forwards the user to the Design stage.

In order to match the preparation model with the occlusion model, the software needs to look in very specific places to find matching data. With potentially rubber dam, cotton rolls, etc., changing position between images, this is no small task for the software. As a result, it looks in two small, well-defined areas to find matching data. If it finds enough matching data, it gives a successful Correlation. If it does not find enough matching data, it either gives a poorly aligned Correlation (rare), or tells the user: “Unable to put together all optical impressions. The faulty ones have been marked and rejected”.

What went wrong? What is going on, and how can one avoid this problem?

The software looks to a small and defined area for matching data between the Preparation and Occlusion images. The white areas below represent the areas where the software looks for matching data between the Occlusion and Preparation images:

If it finds matching data in these areas in both the Occlusion and Preparation images, it will yield a successful Correlation. Let’s take a look at this case from the software’s perspective. Here we have the Occlusion and Preparation images:
The software tries to match the images together by **excluding** the areas marked in blue below:

Notice the small areas in the mesial and distal sections the software uses to match up these images. That is why it is critical to have these areas as identical as possible between the Occlusion and Preparation images.

These two images result in a very accurate Correlation:

We need to remember the software is trying to match data between the two (or more) images. Therefore it follows that we should try to keep these data sets as near identical as we
Powdering - Powdering is one of the three P's of good CEREC restorations (Prep, Powder, Picture) and the necessity of good powdering has not diminished in CEREC 3D. Make sure you follow the proper protocol (clean prep, apply CEREC liquid, dry, spray even coat of powder everywhere inside the camera filed) for both the Occlusal and Prep pictures. The powdering should be as identical as possible in all images.

Picture - the third P! Your pictures should be clear, in focus, and without blurry edges. Blurry edges like the ones shown are often overlooked, but most certainly introduce "noise" into the calculations of the software. Steady the camera with a finger, use a camera stabilizer (C-Stat or Sirona), etc. Also, the two reference images (the Prep and Occlusion image with the red box around them - see left) should also be aligned along the same vertical axis.

And, for the best possible chance at a successful Correlation, the neighboring teeth must be centered buccal-lingually!

Let's look at a case example …
Single Tooth Correlation

Here’s an example of a single tooth Crown Correlation with intact neighbouring teeth. This is the simplest form of Correlation and for the user, the easiest with which to achieve successful results. If you are just beginning with Correlation, this is a good place to start.

When it comes time to take your Occlusion images, try taking the following pictures:

![Image catalog]

Tip: You will notice above all the images are taken with the “Occlusion” icon and stored in the Occlusion window of the Image catalog. This is the simplest and fastest way of taking all your images. Obviously you cannot leave the images this way! However, it is easy to see whether your Preparation picture will line up with your Occlusion image when they are side by side in the Image Catalog like this.

Why did we take 3 Occlusion images?

If you look closely you will see each Occlusion image has a slightly different path of draw. We take the images in this manner in Correlation because until the Preparation is complete, we have no idea what the actual path of draw (insertion) will be! Therefore, it makes sense to take Occlusion images from different paths of draw.

Once the Preparation is completed and the Preparation image has been taken, go ahead and delete the Occlusion images which do not correspond to the Preparation image path of draw. It is recommended to delete the unnecessary images to reduce processing time.

In this case, after reviewing the path of draw of the Preparation image, it was decided to keep only Image 1. Images 2 and 3 were dragged into the Recycle bin (deleted).
These two images have a similar path of draw, so we keep them and delete the rest.

Now the only thing we need to do is drag the Preparation image into the Preparation window of the Image Catalog...

Dragging the Preparation image into the Preparation window of the Image Catalog

This leaves us with one image inside the Preparation window and one image in the Occlusion window:
Now we are ready to Correlate!

Pressing the green arrow will force the software to first create the Preparation model, then create the Occlusion model, then match the two models together by trying to match up the data using the defined areas discussed earlier.
Missing Neighbour Correlation

It has always been possible to Correlate images even when there is a neighbour missing. Here is an example of such a case:

Why do we take the images this way?

When the software cannot match the images with the normal method, it tries one last trick before finally giving up! When there is a missing neighbour the software automatically doubles the area on the mesial side of the images to see if it finds sufficient matching data:
Knowing this we can take our pictures like shown above. This will give us the highest chance of successful Correlation when the distal neighbour is missing.

Multiple Unit Correlation

It is a common misconception that it is not possible to use the Quadrant function with Correlation. While it is possible, achieving a successful Correlation over multiple units can be a challenge. First, take your Occlusion images and Preparation images like so:
Like before, once you are satisfied with all your images, drag your Preparation images into the Preparation window of the Image Catalog:

Note the Reference images (signified by the red bounding box) is the same tooth in both Preparation and Occlusion images!

Now you are ready to Correlate. When you click on the green arrow, what will the software do?

Recall from the Introduction the software first creates the Preparation model by stitching together the images in the Preparation window. Once this is complete, the software then does the same with the Occlusion images creating the Occlusion model. Here is what we have:

Next, the software tries to match the Occlusion model to the Preparation model using the same matching algorithm as in the single tooth case.
However, the software applies this matching scheme over the whole of the model, not just one image. For example:

For this reason it is imperative to keep the following tips in mind for Correlating multiple teeth:

1) Make sure the Preparation and Occlusion models are the same length (start/finish your Optical Impressions in the same place in both Preparation and Occlusion images)

2) Make sure your Reference images (images surrounded by the red box in the Image catalog) are around the same tooth in both the Preparation and Occlusion windows.

Conclusion

In nearly every case it is possible to Correlate using the CEREC 3D software. Naturally, some cases are more difficult than others, but following the points listed in this paper will help ensure you have a high rate of success. Some helpful hints:

1) Powdering and the quality of your Pictures is CRITICAL
2) The reference images (the Prep and Occlusion images with the red box around them) should be the same tooth and aligned as identically as possible
3) Use as many images as you need for a successful correlation, but as few as possible!

Happy Milling!
Your CEREC Team