

# 3M™ Incognito™ Dynamic Wire Offset: The science behind an improvement in archwire-bracket adaptation.



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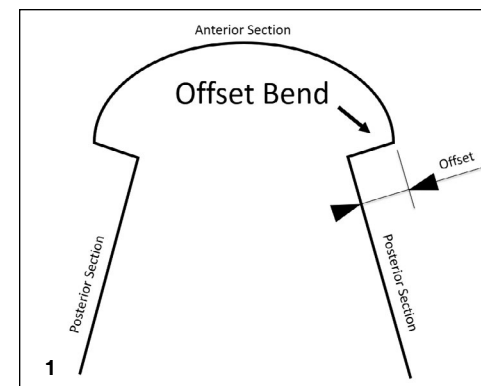
With his group, he develops both mechanical and software solutions for custom lingual orthodontics. He received his diploma in Aeronautical Engineering in 1992 in Braunschweig, Germany, and joined TOP-Service in 2001.

As part of the 3M commitment to continuous improvement, the 3M™ Incognito™ Appliance System has offered significant enhancements over the past few years. Hardware improvements included the 3M™ Incognito™ Clear Precision Tray and the Tip Bar Bracket. There have also been digital developments, such as Digital Setup and the 3M™ Unitek™ Treatment Management Portal (TMP). 3M relies on customer input to help drive the advancements that are offered.

The same is true for enhanced features incorporated into Incognito System archwires. Available since 2016 and well accepted is the Incognito™ Adapted Wire Length, for malocclusions with gaps. And the latest advancement is what we call Dynamic Wire Offset.

To better understand the advantages and the rationale behind Dynamic Wire Offset, it is helpful to look at the basics of lingual archwires. Typical for lingual wires is the mushroom shape, with a more-or-less distinct offset bend between anterior and posterior section (see Figure 1). This offset bend is needed to compensate for the different tooth profiles in the anterior and posterior section. With Incognito system archwires, this offset is very individual, as is the entire wire. It varies from case to case, and sometimes even from one quadrant to the opposing one.

As stated previously it is needed to factor in the patient's individual dentition, but this can also cause problems when there are conflicts with bracket slot positions. It is obvious that a canine can get false rotation, e.g. when erroneously being ligated to the wire segment between anterior and posterior section.



**Figure 1:**  
Lingual mushroom-shaped wire.



### Incognito™ Adapted Wire Length

In 2016, 3M introduced a specific solution for malocclusions with gaps. All Incognito custom wires are based on the setup for a patient arch. The wires are designed to perfectly fit the setup situation. The wires are inactive in the setup situation, as they are not deformed anymore. Before the setup situation is achieved, because of their resulting deformation, the wires are active and apply forces to the teeth, moving them towards the setup situation.

For regular cases, the wire length (based on the setup geometry) matches the malocclusion situation, in most cases good enough to be able to insert the wires. For initial wires this is OK, because in the first phases of a treatment it is not yet about precision anyway. However, for cases having a malocclusion with gaps, the situation is different.

A wire designed for a setup where the gaps are closed is too short to be inserted into a malocclusion situation with gaps. The problem becomes obvious when trying to insert both offset bends between anterior and posterior section, distal to the canines. If the wire is too short to match the malocclusion, it is not possible to get both offset bends distal to the canine slots. In the past, one possible fix was to ligate one quadrant first, close the gaps there, and later ligate the other quadrant to close the gaps there (Figure 2).

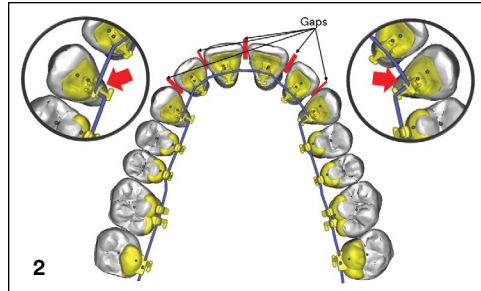


Figure 2: Malocclusion with gaps.

One of the strengths of a digital appliance design is the ability to analyze each individual 3D geometry – specifically the difference between malocclusion and setup situation. For both states, the design software looks at inter-bracket distances. For a malocclusion with gaps, those distances will be larger compared to the setup state. A difference for each inter-bracket distance is computed and then totaled. When the total exceeds a certain threshold, the software determines the appropriate elongation for the wire (Figure 3A-B).

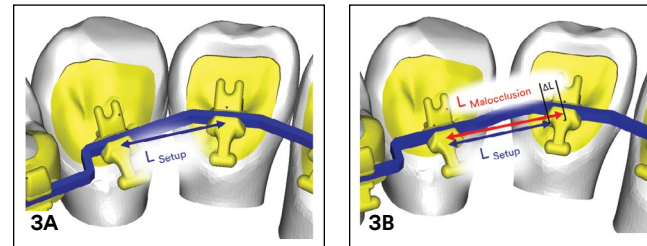


Figure 3A-B: Interbracket distance analysis.

The elongation, representing the accumulation of the gaps, is split up to the individual Inter-Bracket Distances. Gaps totalling to 5 mm compared to the setup situation, add 1 mm for each Interbracket Distance. This results in a wire elongated by 5 mm from 3-3. The slot locations on the wire subsequently move distally starting at the center between the two quadrants. This makes sense, as relative to the center between the two quadrants, the teeth in a malocclusion with gaps are also located more distally. As a result, the wire will be a much better fit for the malocclusion (Figure 4).

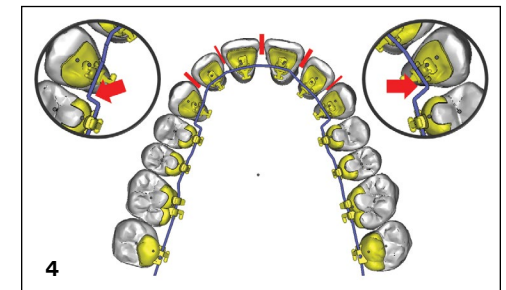


Figure 4: Malocclusion with gaps and adapted wire.

For cases with gaps, the first wire will be manufactured with elongation. Nevertheless, depending on individual strategies to close gaps, the elongation can also be ordered for subsequent SE NiTi wires.

### Incognito™ Dynamic Wire Offset

The TOP-Service lab was approached by some doctors who reported difficulties inserting archwires, especially Super-Elastic NiTi Wires, into the canine slots of regular cases not having the gaps as described above.

For all other malocclusions, we keep the slot locations on the wire according to the setup. This is a well-proven strategy and also works fine for the initial and intermediate phase of the lingual treatment. However, it sometimes can get tight where the wire transitions from the anterior to the posterior section distal to the canine. Then the offset wire bend may conflict with the canine slot and makes wire ligation challenging as it basically is only possible to insert straight wire sections into the slots. The problem is most obvious with SE NiTi wires. Other than steel or Beta III wires those are not bent mechanically, but shape-set in a thermal programming process. This process does not allow for the same sharp bend radii as mechanical bending. This results in smoother wire geometries with softer bends, actually something very useful for the initial phase of a treatment, where brackets often need to travel along the wire. Nevertheless, the larger bend radii tend to increase the problem with the offset bends being too close distal to the canines, as now the bend section extends even more mesially and gets in conflict with the canine slots even more.

When looking at Figure 5, another aspect can be observed. The manufacturing method also has an impact on the bend angle. Due to limitations inherent in the process, angles can deviate from the designed angles of the offset bend. Here especially sharp angles (close to 90°) and small offsets are critical.

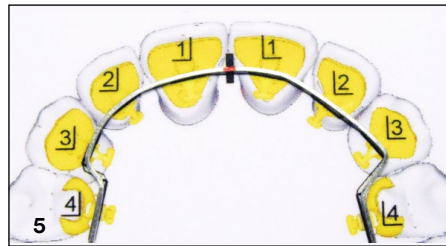


Figure 5: Superleastic NiTi Wire

To avoid the problem, it is necessary to move the offset bend distally. Other than with the wires for malocclusion with gaps here the bracket slots on the wire remain in the original position. They do not move distally. But when doing so it is easy to fall into another trap: A more distal offset bend is at risk to collide with the first posterior tooth typically a premolar, see Figure 6C. This could e.g. restrain to close all gaps. In the past we had a simple strategy to handle this. We defined additional straight wire segments mesial and distal to the actual slot segments. This avoids bends being too close to the brackets and also give some freedom for the brackets to move in mesio-distal direction. For the canines and premolars, we set these additional straight sections to values based on experience.

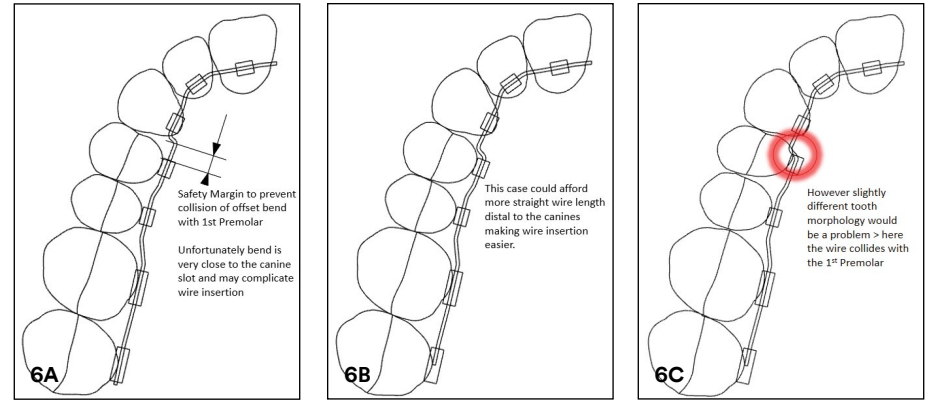


Figure 6A-C: Offset bend locations and potential collision with premolar.

Now, based on customer input, a new approach has been developed. In addition to the settings defining the offset bend location, the design software has been enabled to analyze each individual situation. That allows the bend to be set more distally, away from the canine slot. If this shift results in a collision of the wire with the first posterior tooth or its bracket, the software is able to detect the collision. In that case, the bend is moved mesially, in small increments, until the collision is resolved (Figure 7A-B).

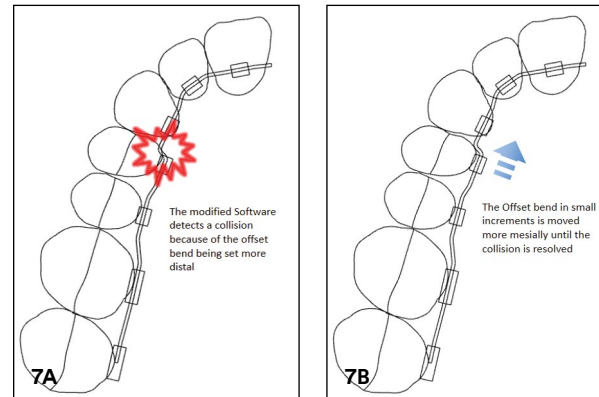


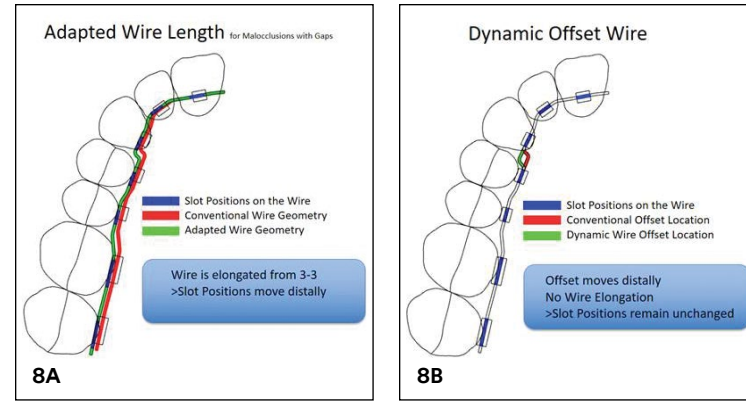
Figure 7A-B: Software resolving a collision of wire and premolar.

The outcome is a wire with an offset bend location that is optimized for each individual case. This wire data now is made available for digital wire manufacturing.

Collision detection is a common and powerful software function also used in other 3D Software, for example, CAD software. It is also used in the Incognito System Setup Software to avoid tooth collisions, which would result in clinical problems.

After developing the necessary software module, doctors who asked for the offset bend modification were provided with modified wires featuring the more distal offset bend and reported significantly easier wire insertion. The positive feedback as well as discussion with other experienced customers led to the decision to make this change available to all customers in August 2018.

For both wire modifications described here, it would visually be hard to notice without knowing about the difference. Nevertheless, the tiny but smart changes to the archwire make a difference for lingual treatment.



**Figure 8A-B:** Illustration and summary of the difference between the two wire changes.