

# Digital Implant Treatment Planning

## The Importance of the Scan Appliance



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One of the fastest growing segments of implant dentistry is the utilization of CT scan data and treatment planning software in conjunction with guided surgery for implant reconstruction cases. The scan appliance is critical to the process and success of these cases. The primary purpose of the scan appliance is to show the ideal prosthetic positions of the teeth to be replaced in the digital plan.<sup>1</sup> By utilizing a scan appliance, the case can be planned from both a prosthetic and surgical perspective, making implantology a truly restoratively-driven process.

There are several excellent implant treatment planning and guided surgery systems available. We will focus on two of the most popular programs on the market: NobelGuide™ from Nobel Biocare and SimPlant® from Materialise (Fig. 1). While the names of their scan appliances are different, their purpose is the same. Which system you choose is typically driven by the implant system you are utilizing. NobelGuide is designed for use with Nobel Biocare implants. SimPlant has an open architecture, so most available implants can be planned with its software.

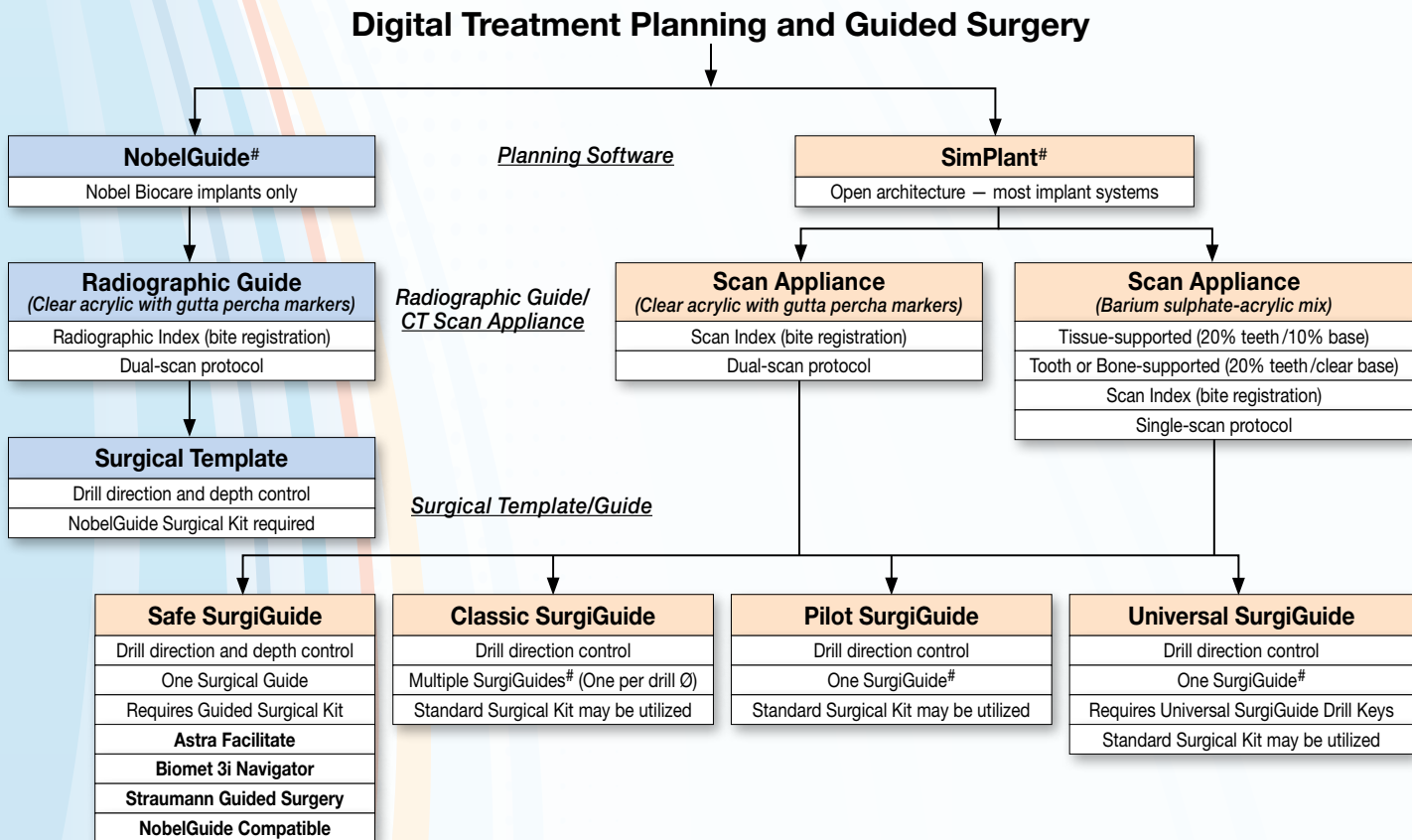


Figure 1: NobelGuide and SimPlant flow chart of terms and options.

## Role of the Scan Appliance

The primary purpose of the scan appliance is to show the ideal prosthetic positions of the tooth or teeth to be replaced. It provides an invaluable diagnostic tool to relate the tooth-to-bone relationship.<sup>2</sup> This is critical for the planning process. While the SimPlant “virtual teeth” function is useful for short spans such as single tooth replacement (Fig. 2), an appliance in which the teeth have been set in the ideal position(s) provides the most accuracy.

Both NobelGuide and SimPlant advocate a dual-scan protocol. In these cases, the surgical guide is literally fabricated from the CT scan of the scan appliance (Fig. 3a-3d).



Figure 2: “Virtual teeth” are inserted to represent teeth #8-10.



Figure 3a: Radiographic Guide

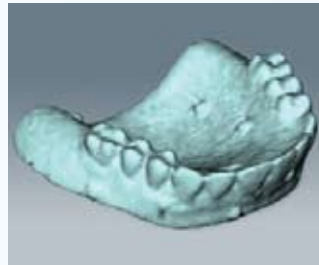


Figure 3b: Virtual rendering of Radiographic Guide

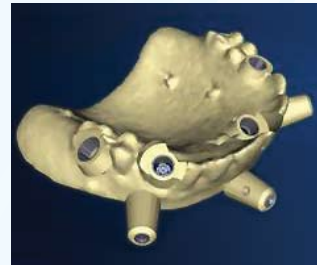


Figure 3c: Virtual rendering of Surgical Template



Figure 3d: Surgical Template

## Types of Scan Appliances

The types of scan appliances can be split into single- and dual-scan protocols (Fig. 4a, 4b). SimPlant traditionally utilizes a single-scan protocol. With the introduction of its dual-scan module, Materialise now recommends the dual scan. NobelGuide utilizes a dual-scan protocol.

**Single-Scan Appliance:** Barium sulphate is mixed with acrylic to identify various structures radiographically. The teeth to be replaced contain a 20 percent barium sulphate mix. If the goal is to perform a flapless procedure on a fully edentulous case, the teeth are made with a 20 percent BaSO<sub>4</sub> mix and the base a 10 percent mix. This allows the teeth to be identified as well as the soft tissue in the CT study.<sup>3</sup> For partially edentulous cases, the scan appliance can be a flipper-type design or it can overlay the remaining teeth, depending on the clinician’s preference.



Figure 4a: Single-scan appliances



Figure 4b: Dual-scan appliance

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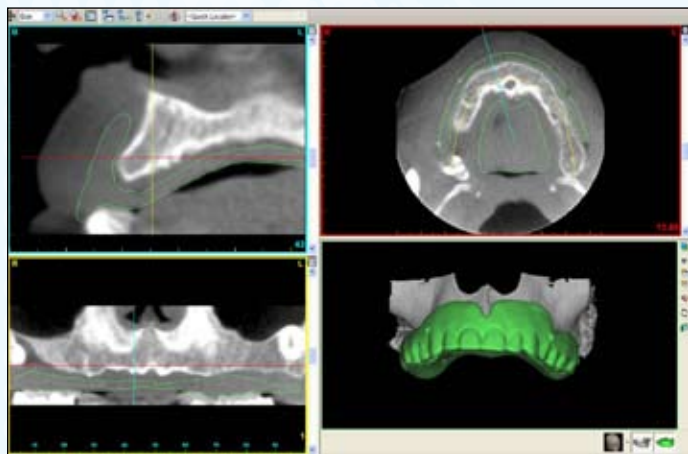
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**Dual-Scan Appliance:** Scatter from neighboring restorations can obscure the view of the teeth in the scan appliance during single scans. Barium sulphate can also cause a minor amount of scatter and potentially obscure the view of vital structures. The dual scan avoids this potential complication. The patient is scanned with the

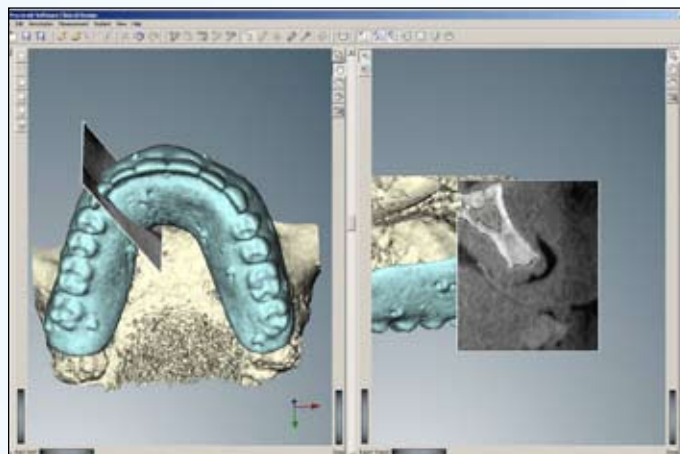
scan appliance, and then the scan appliance is scanned alone. The dual-scan appliance is typically fabricated from clear acrylic with approximately eight 1 mm to 1.5 mm spherical gutta percha markers. The planning software converts the CT scan files and merges the two scans by matching the gutta percha markers, aligning the radiopaque markers so that the prosthesis will be visible over the available osseous anatomy.<sup>4</sup>

## Utilizing the Patient's Existing Denture as a Scan Appliance

While utilizing the patient's existing denture as a scan appliance is possible, it can be problematic. Gutta percha markers can be added to the patient's existing denture, or the denture can be duplicated and utilized only if it is well-fitting



**Figure 5a:** View of well-fitting scan appliance



**Figure 5b:** Radiolucent area shows crestal and facial ridge atrophy. The Radiographic Guide should be hard relined and the case rescanned.

and the teeth are in the correct positions (Fig. 5a, 5b). If the denture is worn down and has a poor fit, a new appliance should be fabricated. For fully edentulous cases, this involves the same steps as fabricating a new denture including wax rims to establish the occlusal records and a wax try-in to evaluate the VDO, CR, tooth set-up and esthetics. (NOTE: This set-up will not only be used to create a proper scan appliance, it can also be used as a guide for the provisional and final prostheses.) By receiving the patient's acceptance of the prosthesis before CT scans are done, the potential for success is also increased.<sup>5</sup>



**Figure 6:** The patient's existing denture was used as the scan appliance. The thin flanges will result in fenestrations and potential weak areas in the surgical guide.

Another issue that can arise when utilizing the patient's existing denture is the thickness, particularly in the flange areas. Dentures, by design, are thin for patient comfort. The scan appliance should ideally be about 3 mm thick. The use of a thin denture could result in fenestrations and potential weak areas in the surgical guide (Fig. 6).

## Verify Fit of the Scan Appliance

Once the scan appliance has been fabricated it should be tried-in to verify fit (Fig. 7). If the lab did not provide one, a scan index should be fabricated. The scan index, or Radiographic Index as it is called in the NobelGuide system, is a bite registration of the scan appliance to the opposing dentition (Fig 8). The purpose of the scan index is to ensure that the appliance remains completely seated during the scan. It must be made out of a radiolucent material so that it does not block out the teeth. We have



**Figure 7:** Try-in of the scan appliance to verify fit. Note: Inspection windows can be used as an aid in partially edentulous cases.



**Figure 8:** Scan appliance and scan index on articulated models.

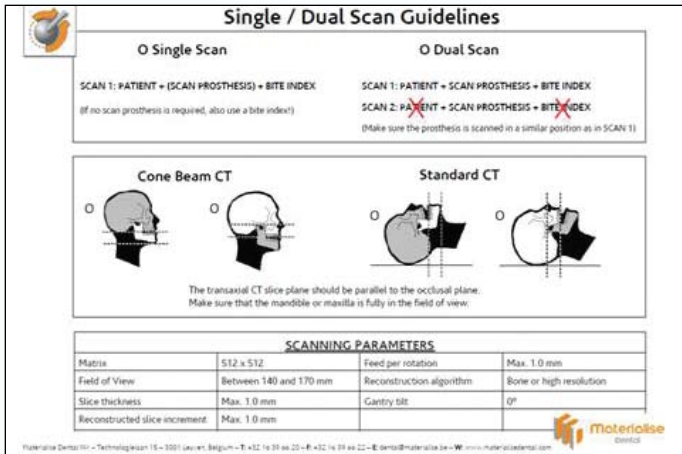


Figure 9a: SimPlant Scan protocol

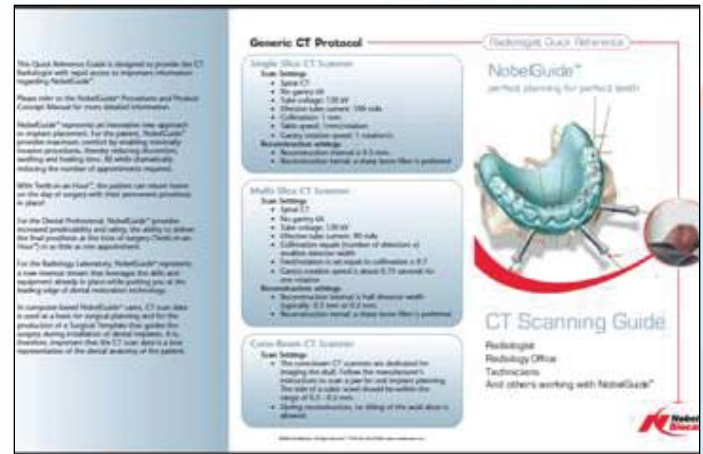


Figure 9b: NobelGuide Scan protocol

found Capture® Clear Bite (Glidewell Laboratories) to be an acceptable material. Once the fit of the scan appliance and scan index are verified, the patient can be sent for the CT scan.

The CT scan protocol for the system you intend to utilize should be followed (Fig. 9a, 9b). The scan protocols for NobelGuide and SimPlant can be found at [inclusivedental.com](http://inclusivedental.com). The scan appliance and scan index must be fully seated for the patient scan. If a dual scan is being utilized (Fig. 10a), the second scan is taken of the scan appliance alone (without the scan index). The appliance should be up off the metal table or bar in the same orientation as it was in the patient's mouth (Fig. 10b). The standard files generated by a CT scan are called DICOM files (Digital Imaging Communication of Medical Images). The radiologist should reconstruct the scan per the protocol. Typically, the radiology lab burns the CT scan data onto a CD. In order to avoid confusion, request that the radiologist create two folders: one containing the DICOM files of the patient scan and, if a dual scan was done, a second folder of the scan appliance. If you are using the NobelGuide or SimPlant software yourself or are utilizing Glidewell Laboratories' Digital Implant Treatment Planning Services, the DICOM files are converted and utilized to virtually plan the case.

The scan appliance and scan index must be fully seated for the patient scan.

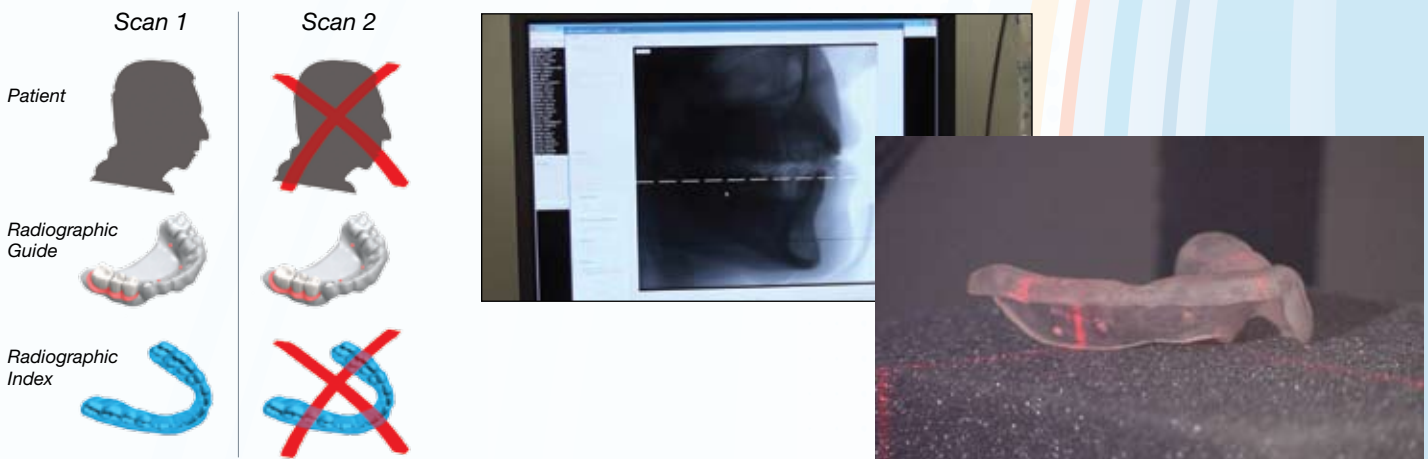
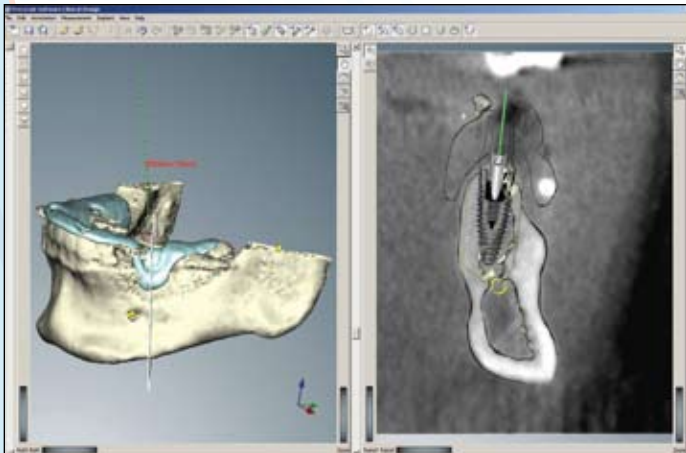


Figure 10a, 10b: Dual scan: The patient is scanned with the scan appliance and scan index. A second scan of the scan appliance alone is performed.

## Single Tooth

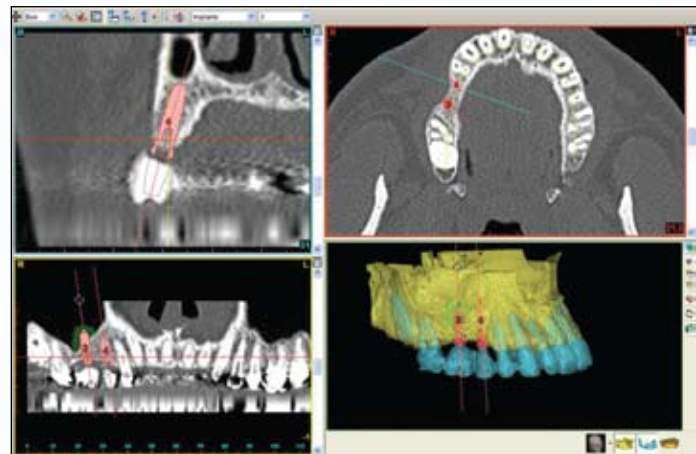


**Figure 11a:** Plan for replacement of tooth #19. The cross-sectional slice through tooth #19 can be seen on the right side of the screen.



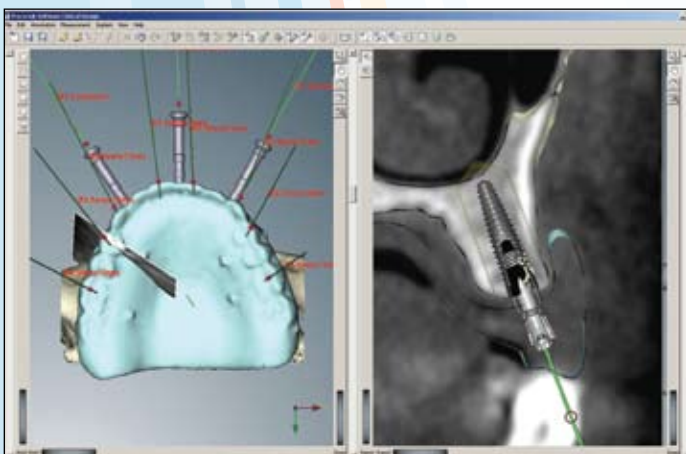
**Figure 11b:** Virtual plan to replace congenitally missing lateral incisors.

## Multiple Teeth

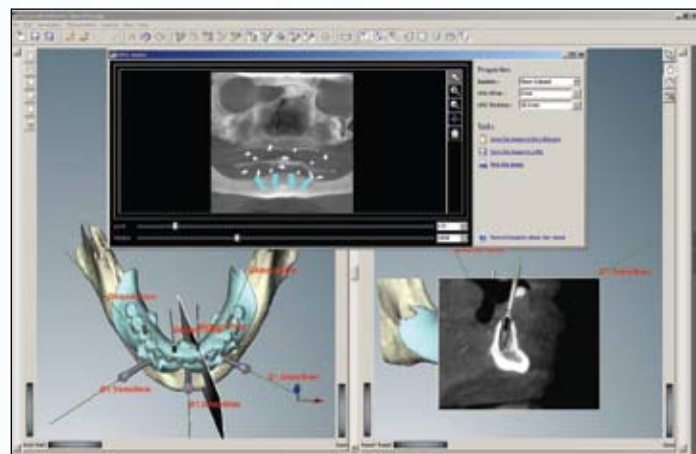


**Figure 11c:** Multiple implants can be planned with appropriate implant-implant and implant-root spacing, as can areas to be grafted.

## Full Arch



**Figure 11d:** Case planned for eight implants for a fixed restoration.



**Figure 11e:** Case plan for a mandibular All-on-4 restoration.

## Restoratively Driven Treatment Planning

The whole point of the diagnostic work-up and utilization of the scan appliance is to show the ideal positions of the tooth or teeth to be replaced. While digital treatment planning guided surgery protocol was initially developed for the fully edentulous patient, it has advantages for partially edentulous patients as well.<sup>6</sup> Whether you are replacing one tooth, multiple teeth or a full arch, digital treatment planning allows you to virtually plan the case from both a surgical and prosthetic perspective in a 3-D environment (Fig. 11a-e). This allows you to make almost all of the clinical decisions up front. The result is implants that are more ideally placed and, therefore, simpler prosthetics and superior restorations. In appropriate cases, the prosthesis can be prefabricated for an immediately loaded restoration.<sup>7</sup> If you plan to immediately load the case, we recommend you deliver a provisional restoration at the time of surgery and then proceed to the definitive prosthesis at a later date.

## Fabrication of the Surgical Guide

Once completed, the virtual plan can be transferred to the clinical setting through the use of a surgical guide. The guide produced for NobelGuide is referred to as a Surgi-Template (Fig. 12a). The guide from Materialise (Sim-Plant) is called a SurgiGuide (Fig. 12b). Using the surgical guides allows the surgeon to place the implants according to a restoratively driven treatment plan.<sup>8</sup> We will review the various types of guides in a future article.



Figure 12a: NobelGuide Surgical Template



Figure 12b: Materialise Simplant SurgiGuide

## Conclusion

Digital treatment planning and guided surgery is rapidly gaining popularity and is becoming a standard of care. A key benefit to this approach is that the case can be planned from the beginning with the final restoration in mind. The scan appliance can be utilized to its fullest by:

- Working with an experienced lab to ensure it is properly fabricated
- Verifying clinically that it and the scan index fit well and are completely seated for the CT scan
- Ensuring the radiologist is familiar with the scan protocol.

By understanding the role and proper use of the scan appliance in the digital implant treatment planning and guided surgery process, the clinician can take full advantage of this technology. ■

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