

TWO EBOOK SERIES



How to do dentures digitally

A step-by-step guide to intraoral scanning edentulous patients and designing and manufacturing dentures

EBOOK **TWO**

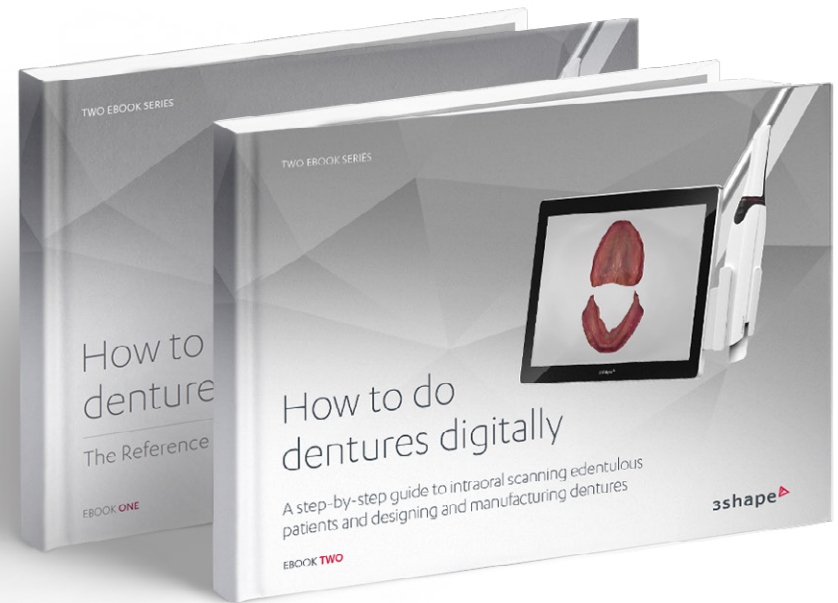
3shape 

Two-eBook series

3Shape has created a two-part eBook series focusing on the important protocols within the digital denture ecosystem. The two eBooks include protocols for capturing clinical records, digitizing these records, utilizing an intraoral scanner, and optimizing your workflows.

Each eBook, in the two-part series, focuses on a protocol for capturing scan data using an intraoral scanner and the workflows needed to document the patient's oral situation.

This eBook outlines data acquisition on a fully edentulous patient using only the 3Shape TRIOS intraoral scanner. The book also includes a tutorial on how to document a patient's maxillo-mandibular relationship by means of digitally scanning occlusal rims.



Background

According to the American College of Prosthodontists, more than 36 million Americans are completely edentulous, with 120 million people in the USA missing at least one tooth. These numbers are expected to grow in the next two decades.

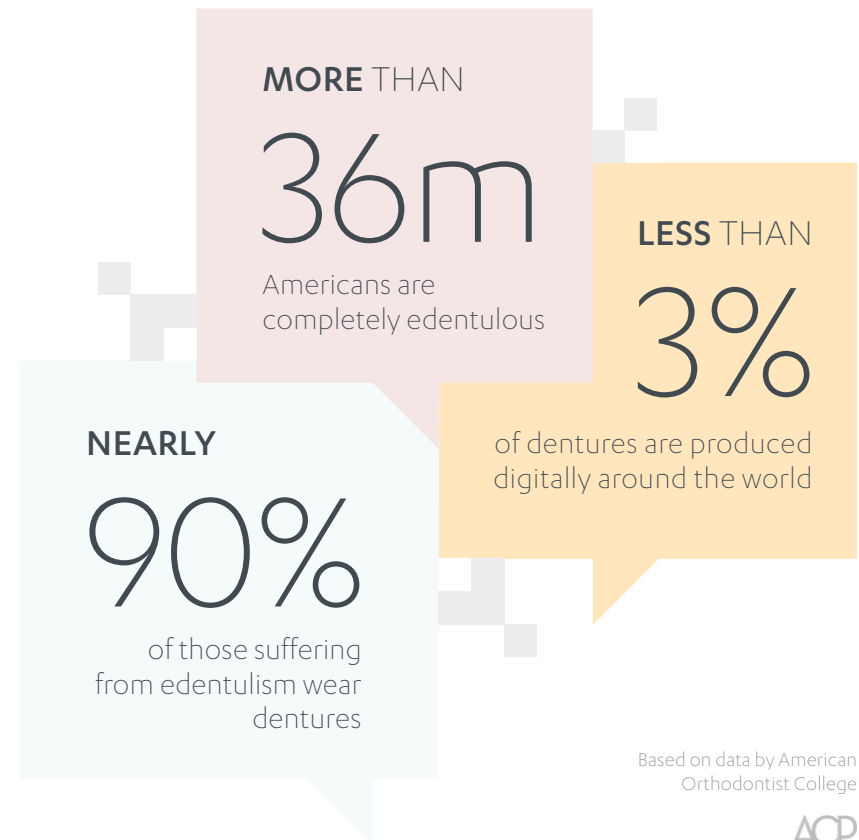
In the USA's geriatric population, the ratio of edentulous individuals is 2 to 1. About 23 million are completely edentulous with approximately 12 million edentulous in one arch.

Of the edentulous population, 90 percent of those suffering from edentulism wear dentures. With the number of partially edentulous patients expected to grow over the next 15 years to more than 200 million.

According to global statistics, some 50 million removable dentures are produced per year. With less than 3% being digitally produced.

These numbers highlight that the need for dentures is growing exponentially. This eBook series will provide you with important insights and techniques to help you meet the growing demand. And do so, with more efficient and predictable outcomes, according to the contributors to this eBook.

Whether you are a dentist, lab technician, or denturist, this denture two-eBook series will help you to take advantage of digital pathways to create dentures.



Prof. Dr. Lucio Lo Russo's Denture Protocol

Over the last five years, Prof. Dr. Lo Russo has developed denture protocols and treatment workflows based solely on edentulous intraoral scanning. At the same time, he has published numerous articles clinically documenting the accuracy of workflows based on intraoral scans.

While professionals' methods may differ, the contributors to this series unanimously agree that scanning and producing dentures digitally leads to a reduction in chair time, less appointments, and consistency in the quality, design and fit of your restorations.

Dutch dentist, Germen Versteeg adds that since going digital, his business has grown by 300%!



Prof. Dr. Lucio Lo Russo's Denture Protocol

Scanning **edentulous patients**

Back in 2019, Italy's Prof. Dr. Lucio Lo Russo shook up the audience at the IDT conference in Atlanta with a presentation on the design and production of dentures based entirely on 3Shape TRIOS intraoral scans.

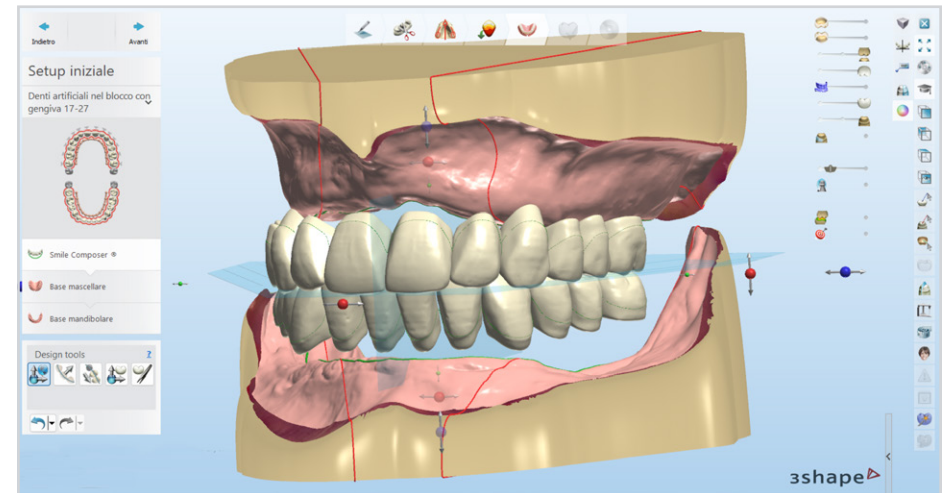
A doctor who attended, said that if there was one image that stuck in his mind during the two-day show, it was the photo documenting the incredible fit of one of Prof. Dr. Lo Russo's dentures in a patient's mouth.



Starting **from scratch**

What is interesting about Prof. Dr. Lo Russo's workflow is that his denture designs are based solely on intraoral scans.

Aside from scanning the edentulous patient, Prof. Dr. Lo Russo uses the scanner to document the intraoral maxillo-mandibular relationship and align the scans, while at the same time registering all information for tooth arrangement. He then transfers this data into the CAD software for denture design.



Prof. Dr. Lucio Lo Russo's Denture Protocol

Documenting accuracy in **edentulous intraoral scanning**

According to Prof. Dr. Lo Russo, most people believe that it is not possible to begin the removable denture workflow with an intraoral scan. They wrongly believe that it is too difficult to learn how to scan an edentulous arch and that an intraoral scan is not accurate enough to design dentures from.

Prof. Dr. Lo Russo is on a mission to disprove this with his edentulous scan strategy and with his research on the accuracy and consistency of edentulous scans.

He has spent years researching and documenting that the concerns related to the use of intraoral scans for dentures are, in fact, not evidence based.

In his research, Prof. Dr. Lo Russo states that capturing anatomical data of edentulous arches using 3Shape TRIOS scans is a definite option. He has published popular research demonstrating and concluding that intraoral scans are feasible and accurate enough for dentures and/or at least as much so as conventional impression procedures.

A list of references from Prof. Dr. Lo Russo can be found at the end of this eBook.

Three-dimensional differences between intraoral scans and conventional impressions of edentulous jaws: A clinical study

Lucio Lo Russo ¹, Giammarco Caradonna ², Giuseppe Troiano ², Angelo Salamini ³, Laura Guida ⁴, Domenico Ciavarella ⁵

Affiliations + expand

PMID: 31153614 DOI: 10.1016/j.prosdent.2019.04.004

Abstract

Statement of problem: Using intraoral scans for removable dentures has been questioned because of a suggested lack of accuracy. However, data regarding the accuracy of digital intraoral complete-arch scans are sparse, present some methodological issues, and mostly come from in vitro studies on dentate casts, which are very different from edentulous arches.

Purpose: The purpose of this clinical study was to evaluate 3D differences between intraoral scans (IOS) and conventional impressions of edentulous arches by means of digital analysis.

Material and methods: Ten maxillary and 10 mandibular edentulous arches were investigated. For each of them, IOS was performed, and a custom tray was digitally designed based on these scans. Trays were built by using a 3D printer and used to make a conventional impression with a polysulfide impression material. The conventional impression was scanned immediately by using the same intraoral scanner and by the same dentist. Standard tessellation language (STL) files of IOS and the scans of the corresponding conventional impressions (CIS) were superimposed with a 2-phase best-fit alignment in a reverse engineering software program. The corresponding full-

Digital dentures: A protocol based on intraoral scans

Lucio Lo Russo ¹, Angelo Salamini ², Giuseppe Iroiano ³, Laura Guida ⁴

Affiliations + expand

PMID: 32331785 DOI: 10.1016/j.prosdent.2020.02.006

Abstract

The use of intraoral scans for complete denture fabrication may improve patient comfort, clinic ergonomics, and laboratory efficiency. Techniques have been reported regarding specific tasks related to the use of intraoral scans for digital dentures, but an integrated workflow is still lacking. This technique article describes a complete workflow for the digital fabrication of complete dentures, starting from intraoral scans and with no physical casts; in addition, the presented workflow integrates partial and complete face scans in the design process to optimize tooth arrangement.

Copyright © 2020 Editorial Council for the Journal of Prosthetic Dentistry. Published by Elsevier Inc. All rights reserved.

Dr. Lo Russo's Denture Protocol

Digital versus conventional methods

Prof. Dr. Lo Russo has created a workflow that makes use of intraoral scans of edentulous arches aligned by using occlusal rims. The occlusal rims are also used to determine the maxillo-mandibular relationships and all the other parameters for tooth arrangement.

According to Prof. Dr. Lo Russo, an advantage of the digital workflow is that intraoral scans capture oral tissue in a passive state. Thereby creating a mucostatic impression that can be advantageous in certain situations, such as with sharp, thin, flat, or flabby residual ridges.

Prof. Dr. Lo Russo also claims that intraorally scanning the patient is much more comfortable and takes less time.

In an interview with 3Shape, Prof. Dr. Lo Russo says, "if the patient has any type of gag reflex or allergy to impression material, the conventional impression procedure can become a very negative experience for the patient. On the other hand, with intraoral scans this is completely avoided and, most of the time, patients that have experienced conventional impressions are favorably surprised."

He continues, "scanning an edentulous arch is much faster than waiting four minutes for conventional impression material to finally set. For us, on average, it takes about one minute to scan the edentulous maxilla and even less for the mandible. Of course, there can be variations from case to case or the patient.

On top of saving time, there's no need to ship the impression or cast to a lab, so I save time and money. **Basically, every step in the conventional workflow requires additional time, additional material, additional costs and most important, adds a potential source of error. With analog, we lose standardization, and we can lose accuracy when we arrive at the final denture.**

Lastly, aside from the wear and tear that can result in sending a conventional impression or physical casts back and forth, another important aspect to consider is all these objects which were in contact with the patient's mouth are theoretically, potentially infected. So, if we are not transferring anything from the clinic to the lab, we are reducing and controlling, any risk of infection."

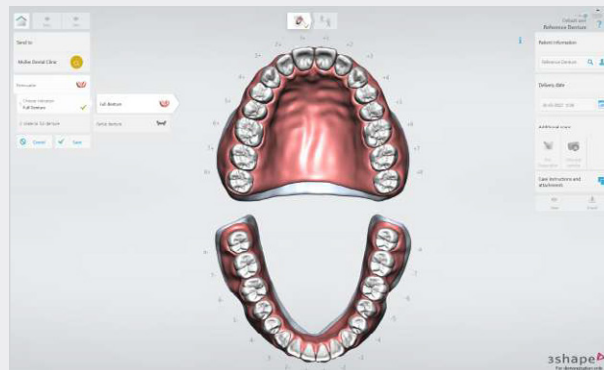
Denture workflow starting from intraoral scans

Step-by-step

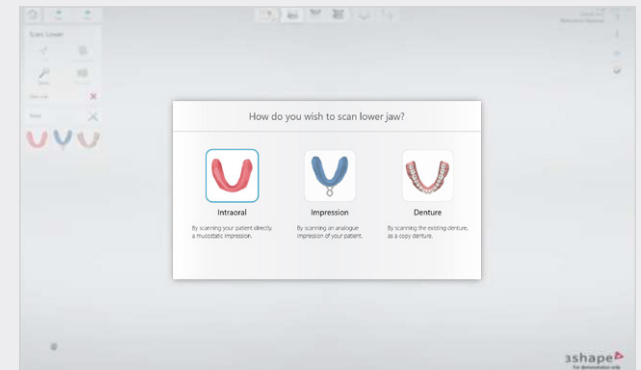
Step 1

Setting up the order form

Under the order form creation in 3Shape Unite, select the removeable scanning indication. Once you have selected the removeable indication and manually selected the arches that you wish to scan, the system will prompt you and ask: How do you wish to scan the lower/upper jaw? Since we are doing a digital mucostatic impression, we will be selecting "Intraoral" scan.



Select the "removable" scanning indication in the Unite order form.



Select "intraoral" scan in the TRIOS scan module.

Denture workflow starting from intraoral scans

Step-by-step

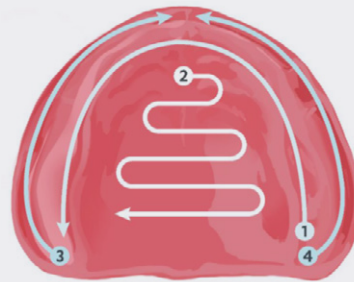
Step 2

Capturing intraoral scans of edentulous arches

According to Prof. Dr. Lo Russo, edentulous arches can be scanned reliably and fast using 3Shape TRIOS scanners. He suggests that you take your time and have a clear scan strategy in mind. You can follow his step-by-step scan strategy presented in the next paragraphs. Adequate retraction and stabilization of mobile tissues surrounding the residual ridge are relevant factors in scanning edentulous arches. In order to simplify these tasks and improve the scanning experience, the specialized tool 'Lo Russo Retractors' can be used (more details about them can be found here: www.lorusso retractors.com).

Step 2.1

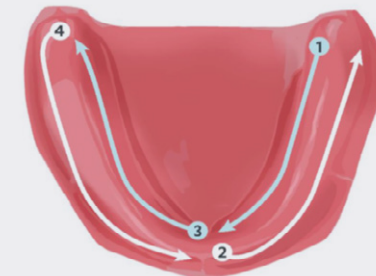
Edentulous maxilla scan strategy



- 1 Start the scanning process from the tuberosity area of one side and proceed along the center of the residual ridge towards the tuberosity area of the opposing side.
- 2 Come back to the midline and complete the scan of the palate with smooth movements from side to side.
- 3 Proceed scanning the buccal side of the ridge from the tuberosity area towards the midline and stop the scanner.
- 4 Now scan the opposing buccal side of the ridge from the tuberosity area towards the midline.

Step 2.2

Edentulous mandible scan strategy



- 1 Start to scan from the retromolar area staying a bit on the lingual side of the ridge and proceed towards the midline.
- 2 Continue scanning towards the retromolar area while staying on the buccal side of the ridge. Stop the scanner. Let the patient relax for a while, remove saliva, and then continue.
- 3 Restart the scanning from the midline and proceed towards the retromolar area staying a bit on the lingual side of the ridge.
- 4 Continue scanning towards the midline while staying on the buccal side of the ridge. When you have scanned the edentulous arches, skip the step of scanning the occlusion, and send the scans to an in-house or external lab to be used to fabricate occlusal rims.

Denture workflow starting from intraoral scans

Step-by-step

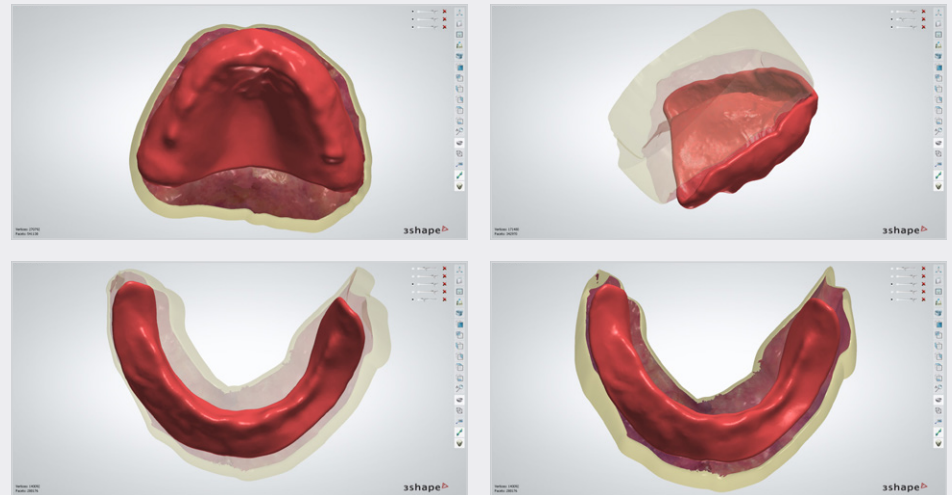
Step 3

Fabrication of the occlusal rims

The occlusal rims required in this step are fabricated by the lab as follows:

The baseplate for the occlusal rims can be designed in 3Shape Dental System CAD software in-house or by your laboratory who creates an order for individual impression trays. Remember to set the space for the impression material ("Impression gap" in 3Shape Dental System CAD software) to zero so that the baseplate is completely adapted to the mucosa: this is very important for the subsequent scans alignment procedure.

Once designed, the baseplates of the occlusal rims can be printed. The occlusal rims are then finalized by adding wax to the printed baseplate.



The baseplate for the occlusal rim is designed in 3Shape Dental System CAD software

Denture workflow starting from intraoral scans

Step-by-step

Step 4

Determining the maxillo-mandibular relationship

This next section covers Prof. Dr. Lo Russo's workflow for aligning completely edentulous maxillary and mandibular arches to the digitized maxillo-mandibular relationship registered with occlusal rims. In addition, using the same procedure, Prof. Dr. Lo Russo demonstrates that information for tooth arrangement can then be registered and transferred to the digital workflow for denture design.

Step 4.1

Jaw relation records

When you have the occlusal rims ready, the maxillo-mandibular relationship can be registered by either of the following ways:

- 1 A simple wax recording technique: After the identification of a reproducible mandibular position, create notches on the occlusal aspect of both occlusal rims and place recording material. Then, gently guide the mandible into the registered jaw relation and hold in place until the material has completely set.
- 2 An intraoral registration (gothic arch) technique: All the necessary equipment can be added to the occlusal rim, and you can proceed as usual.

Denture workflow starting from intraoral scans

Step-by-step

Step 4.2

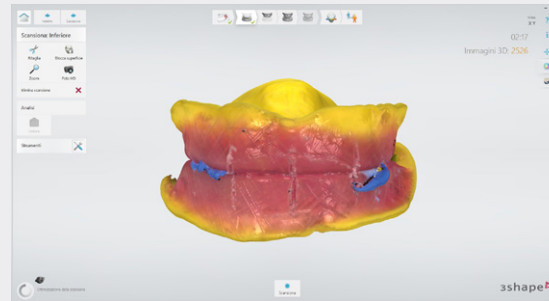
Scanning the occlusal rims

In the Unite software, reopen the order of the intraoral scans, go to the occlusion step, and select the "bite tray" option for registering the bite.

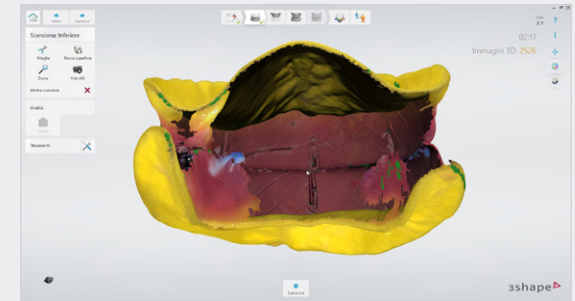
Remove the registered occlusal rims from the mouth while keeping the maxillary and mandibular occlusal rims together to preserve the registered jaw relation. Adding small markings on the wax may be a useful tip.

Then scan the occlusal rims as one object with your TRIOS scanner by following these steps:

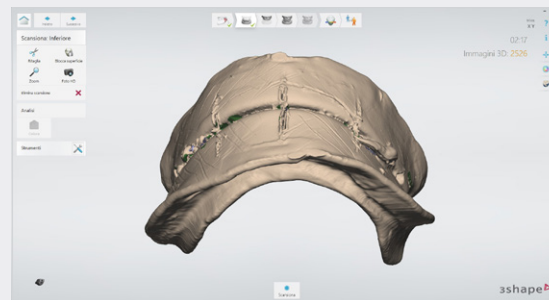
- 1 Start from the intaglio surface of the maxillary occlusal rim
- 2 Move outside the intaglio surface to capture the buccal surface of the wax
- 3 Finally proceed with scanning the intaglio surface of the mandibular occlusal rim.



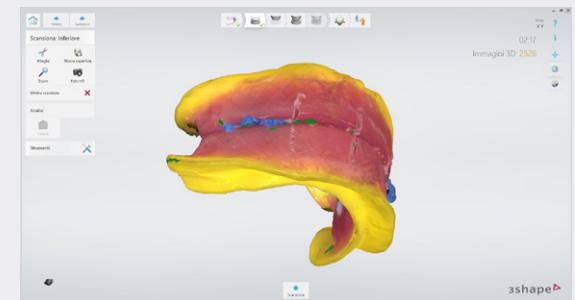
Scanning the occlusal rim as one object in the occlusion step.



You can choose to leave out the lingual surface from the scan to save scan time.



If you prefer to turn the colors off when checking your scan, you can do this by clicking the 'color wheel' icon in the right-side panel.



Occlusal rim seen from below.

Denture workflow starting from intraoral scans

Step-by-step

Step 4.3

Aligning the intraoral scans or edentulous arches

Using the intaglio surfaces of occlusal rims just scanned, you can align the edentulous arch scans by following the guidance in the software.

When finished, the intraoral scans are aligned and ready to be sent to the in-house or external laboratory for design of the denture in 3Shape Dental System CAD software.

Alternatively, the occlusal rims can be sent to the lab and scanned with a desktop scanner. Thus, scanning the occlusal rims with the TRIOS scanner improves efficiency as you avoid shipping the occlusal rims and prevents transferring potentially infective objects.

Denture workflow starting from intraoral scans

Step-by-step

Step 5

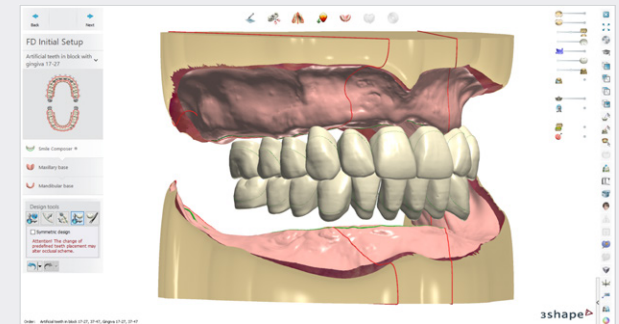
Designing the denture

Upon completion of this protocol, you are ready for denture design having used a completely digital workflow aided by physical occlusal rims. Such a “scan, align, design” approach makes it possible to improve patient comfort, and your practice and/or laboratory’s efficiency.

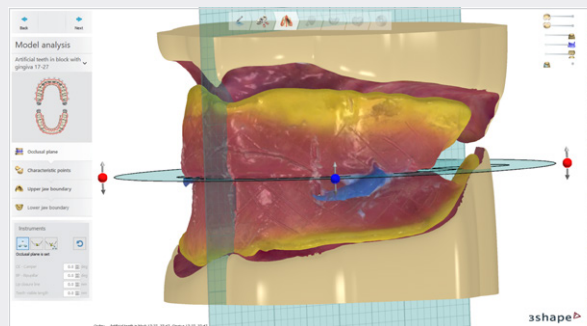
Step 5.1

Designing the trial and final denture

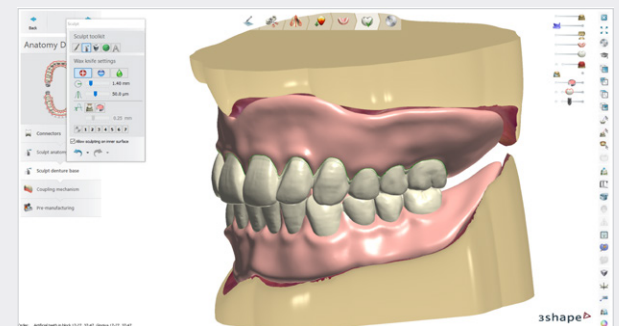
Using 3Shape Dental System for example, the denture design is a very straightforward process. It offers all the tools you need for a reliable and user-friendly tooth arrangement and denture individualization, as well as the opportunity to choose several options for the denture design itself; monobloc, denture base with stock teeth, or in-house fabricated teeth, and the manufacturing technology (milling, 3D printing).



The denture smile setup in Smile Composer, Dental System.



Setting the occlusal plane in Dental System.



Final denture in Dental System.

Denture workflow starting from intraoral scans

Step-by-step

Step 5.2

Trial denture

Once your denture design is completed, the verification of esthetics, phonetics, and maxillomandibular relationships can easily be performed by means of a trial denture before the definitive denture fabrication.

Although the esthetic outcome can be previewed with proprietary templates or by integrating face scans into the denture design workflow, aspects other than the esthetics cannot be verified in a virtual environment. For this reason, trial placement remains clinically advisable; omitting it may reduce the number of patient appointments, but it should not be avoided, according to Dr. Lo Russo.

Step 5.2.1

Trial denture materials and manufacturing

In a digital denture workflow, trial dentures can be fabricated by using either milling or 3D printing, which may affect tooth position and gingival appearance, fabrication costs and efficiency, and the possibility of adjusting both teeth and borders during the clinical evaluation.

3D printed trial dentures are more cost and time efficient compared to milled trial dentures. The most used 3D-printing technologies for trial complete dentures use photopolymerizing resins. Although effective, some issues related to their clinical application (possibility of making and recording chairside adjustments), processing (effect

of layer thickness and position on build platform), and practical considerations (access to technology, equipment maintenance) may be disadvantageous to some extent.

The fused deposition modeling technology has recently been recognized as an affordable option. This uses a variety of inexpensive thermoplastic materials, with equipment requiring minimal maintenance. The finish is less smooth, but the dimensional accuracy is high and the slower printing is counterbalanced by the absence of postprocessing.



An example of trial denture 3D printed by means of fused deposition modeling technology.

Denture workflow starting from intraoral scans

Step-by-step

Step 5.3

Final denture

Denture manufacturing can be performed according to the preferred technology. Both milling and 3D printing is possible.

Currently, milling is a common manufacturing process, especially for definitive complete dentures. Nonetheless, 3D printing hardware and materials are rapidly evolving with a greater and greater potential.

It has recently been reported that 3D printing has the capability to provide intaglio surface accuracy with minimal difference in comparison with milling.

Considering variable and opportunity costs, digital denture workflows (both milling and 3D printing) are characterized by significantly lower cost than the conventional technique. The greatest efficiency and cost minimization can be obtained with 3D printing.

The developed protocol, based on intraoral scans detailed in the present eBook, was validated with milled denture bases and milled teeth; these are assembled by using a fast-polymerizing acrylic resin. The finishing and polishing of the assembled denture base and teeth, as well as of the denture manufactured in a monobloc, can be performed using common procedures.



Milled denture base just removed from the disc.



The fit of milled denture base and milled teeth is checked before assembling them.

Step 6

Denture delivery

You have successfully fabricated your digital denture made from intraoral scans and can deliver it to your patient already at the 3rd patient visit.

About Lucio Lo Russo

Lucio Lo Russo, DDS, PhD, is Professor of Prosthodontics at the School of Dentistry, University of Foggia, Italy. He is involved in basic and applied clinical research related to the diagnosis, treatment, and rehabilitation of oral diseases, particularly in the field of Prosthodontics and Digital Dentistry, Periodontology, and Oral Medicine. He has published more than 160 scientific papers, most in high-impact international scientific dental and medical journals.

About 3Shape

3Shape was founded in 2000 by two people determined to unlock opportunities in 3D digital technology. From two, we've grown to over 2,000 – and from our beginning in Denmark, we're now present in over 100 countries around the world.

Our singular purpose remains the same – to advance and connect medical professionals and patients.

We drive progress in digital dentistry with groundbreaking, industry-recognized scanners for clinics and labs. And connect dentists and technicians with software workflows that just flow. We advance and coach professionals on every step of their digital journey – helping to truly elevate the customer experience.

Our impact is reflected in the results we achieve. Every second of every day, our award-winning products restore the confidence of a patient. Decisively going beyond products, we bring ongoing training and education that not only helps professionals stay relevant, it puts them ahead of the game.

We actively advance and connect dentists and lab technicians – the people who are the backbone of the industry.

Advance. Connect. Together.

www.3shape.com

Further readings

Lo Russo L, Salamini A. Removable complete digital dentures: A workflow that integrates open technologies. *J Prosthet Dent* 2018;119:727-32. <https://doi.org/10.1016/j.prosdent.2017.06.019>.

Lo Russo L, Salamini A. Single-arch digital removable complete denture: A workflow that starts from the intraoral scan. *J Prosthet Dent* 2018;120:20-4. <https://doi.org/10.1016/j.prosdent.2017.09.004>.

Lo Russo L, Ciavarella D, Salamini A, Guida L. Alignment of intraoral scans and registration of maxillo-mandibular relationships for the edentulous maxillary arch. *J Prosthet Dent* 2019;121:737-40. <https://doi.org/10.1016/j.prosdent.2018.06.022>.

Lo Russo L, Caradonna G, Salamini A, Guida L. A single procedure for the registration of maxillo-mandibular relationships and alignment of intraoral scans of edentulous maxillary and mandibular arches. *J Prosthodont Res* 2020;64:55-9. <https://doi.org/10.1016/j.jpor.2019.04.009>.

Lo Russo L, Di Gioia C, Salamini A, Guida L. Integrating intraoral, perioral, and facial scans into the design of digital dentures. *J Prosthet Dent* 2020;123:584-8. <https://doi.org/10.1016/j.prosdent.2019.05.030>.

Lo Russo L, Troiano G, Salamini A, Guida L. Intraoral scans alignment in single edentulous arch cases. *J Prosthodont* 2020;29:826-8. <https://doi.org/10.1111/jopr.13254>.

Lo Russo L, Caradonna G, Salamini A, Guida L. Intraoral scans of edentulous arches for denture design in a single procedure. *The Journal of Prosthetic Dentistry* 2020;123:215-9. <https://doi.org/10.1016/j.prosdent.2019.03.022>.

Lo Russo L, Caradonna G, Troiano G, Salamini A, Guida L, Ciavarella D. Three-dimensional differences between intraoral scans and conventional impressions of edentulous jaws: A clinical study. *J Prosthet Dent* 2020;123:264-8. <https://doi.org/10.1016/j.prosdent.2019.04.004>.

Lo Russo L, Lo Muzio E, Troiano G, Salamini A, Zhurakivska K, Guida L. Accuracy of trial complete

dentures fabricated by using fused deposition modeling 3-dimensional printing: An in vitro study. *J Prosthet Dent* 2021S0022-3913(21)00416. <https://doi.org/10.1016/j.prosdent.2021.07.021>.

Lo Russo L, Park JM, Troiano G, Salamini A, Lo Muzio E, Guida L. Assessment of tooth displacement during the cast-free digital processing of milled dentures. *J Prosthet Dent* 2021;Accepted May 19:S0022-3913(21)00267. <https://doi.org/10.1016/j.prosdent.2021.04.028>.

Lo Russo L, Salamini A, Troiano G, Guida L. Digital dentures: A protocol based on intraoral scans. *J Prosthet Dent* 2021;125:597-602. <https://doi.org/10.1016/j.prosdent.2020.02.006>.

Lo Russo L, Guida L, Zhurakivska K, Troiano G, Chochlidakis K, Ercoli C. Intaglio surface trueness of milled and 3D-printed digital maxillary and mandibular dentures: A clinical study. *J Prosthet Dent* 2021;accepted May 19:S0022-3913(21)00262. <https://doi.org/10.1016/j.prosdent.2021.05.003>.

Lo Russo L, Troiano G, Santarelli A, Salamini A, Gallo C, Guida L. Trueness of Intaglio Surface of Milled Digital Dentures Designed from Intraoral Scans. *J Prosthodont* 2021. <https://doi.org/10.1111/jopr.13393>.

Lo Russo L, Zhurakivska K, Guida L, Chochlidakis K, Troiano G, Ercoli C. Comparative cost-analysis for removable complete dentures fabricated with conventional, partial, and complete digital workflows. *The Journal of Prosthetic Dentistry* 2022. <https://doi.org/10.1016/j.prosdent.2022.03.023>.