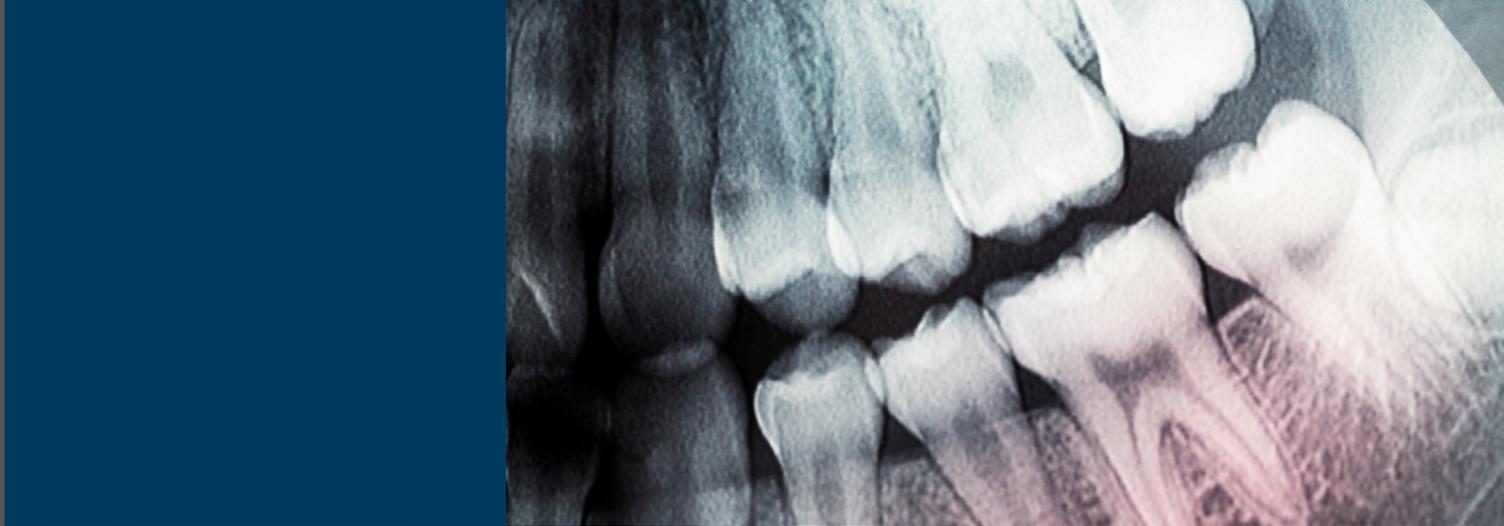


Dental Investment Casting

Increase Cast Frame Production Through Digital Printed Technology and Nobilium's CADVest



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Several dental treatments replace missing teeth with a customized removable partial denture. Manufacturing these removable partial dentures traditionally involves multiple steps and is incredibly labor-intensive. Mainstreaming the manufacturing processes of cast chrome partials was facilitated through the use of 3D printers, PolyJet™ materials and Nobilium's CADVest investment technique. The combination of both technologies with the optimization of digital dental technology provides an enhanced level of accuracy, reproducibility and production. This paper discusses how to use both solutions for the common goal of elevating restorative dental practices.

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Traditional Manufacturing

When a patient arrives in a dental office with missing teeth in multiple locations, one restorative option is a cast partial denture. A cast partial denture is made of chrome cobalt for strength, durability, retention and stability, and is coupled with acrylic when mimicking natural gingiva is necessary. Traditional manufacturing methods require the laboratory to duplicate the working model in order to wax-up the cast frame.

At this point, careful attention should be paid to the tooth and gingival undercuts, as well as the proper placement of clasps and minor and major attachments, all in an effort to ensure proper functionality and longevity of the dental appliance. It is critically important to block out undercuts to ensure good adaptation of the cast partial framework. This process is incredibly time-consuming and costly, and may introduce multiple opportunities for inconsistencies and potential inaccuracies.

These potential inaccuracies and inconsistencies are due simply to human involvement. The placement of clasps, the thickness of the wax mesh and minor connectors are areas subject to variation and inconsistencies with the traditional methods. Digital design and 3D printing help eliminate these inconsistencies.

Digital Solutions

Dental professionals can now use sophisticated design software to create the same vital processes in the virtual world with the advancements of computer-aided design (CAD) and computer-aided manufacturing (CAM). With digital solutions the oral cavity or working model is scanned and imported directly into the design software. There, the dental professional can mark and fill (block out) any tooth or gingival undercut on the model that is rendered in the software.



Partial frames, like these two maxillary (upper) arches, can be time- and labor-intensive if created via traditional manufacturing. Digital dentistry improves the time to make and accuracy of partial frames.

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Once the undercuts are ready, the dental professional chooses and places the selected clasps on the virtual model and then attaches them to the minor connector, followed by the major connectors of the cast partial framework. This digital process produces an optimal partial denture design with enhanced accuracies at a significantly reduced time frame, allowing for more designs to be generated.

Once the digital design is completed and validated, the partial denture framework is 3D printed.

Stratasys offers several dental solutions to fit any need. For this application, the 3D printer* uses the biocompatible (MED610™) photopolymer, which is a rigid medical material used for prototyping items such as surgical guides, orthodontic appliances, and delivery and positioning trays. The material is dimensionally stable, and has a long time horizon before dimensional distortion – far superior to any of its competitors' or predecessors' materials.

Furthermore, 3D printers like the Objet500 Dental Selection™ provides a consistent and accurate model, with horizontal build layers as fine as 16 microns.

The sprue location is a critical factor when printing and then investing. For single-cast framework

rings, the sprue – the point of the cone attachment – should be in the middle of the frame and in line with the top of the rests when investing one case in one ring/mold. For multiple frame rings, the sprue should be at the distal of the frame in line with the most distal point of the frame. This allows you to invest more than one frame in one ring/mold.

When 3D printing, re-orient the frame on the print plate to stop the support material from creating a texture on the junction between the support and bio-compatible materials that would adversely affect the fit. Using the zoom tool from the top view, you can look down the guide planes and tilt the frame to remove as much undercut as possible. After printing and cleaning, dry the cases and paint Dafna Waterfree wax on the textured surface – this helps fill in the texture and provide a clean surface.

Among the many benefits of the digital manufacturing processes, the greatest benefit is an estimated reduction of at least 50 percent in labor and time costs. The steps listed above, that traditionally required the attention of a skilled technician working for multiple hours, can now be reduced to minutes with the same level of expertise derived from the same technician.



This cast frames, left, was created with the help of 3D printed biocompatible (MED610) material, right.

* Printers compatible with Biocompatible Clear (MED610) include: Objet30 Dental Prime, Objet260 Dental, Objet260/500 Dental Selection, Stratasys J700 Dental, and Stratasys J720 Dental.

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Similarly, printing the partial denture frames is significantly more cost-effective due to the reduction of 3D print time. A single frame can be printed in as little as 20 minutes and 30 frames can be printed in as little as eight hours, showing digital dentistry to be an incredibly production-friendly technology.

Nobilium's CADVest

The printed framework is invested using Nobilium's newly developed CADVest – a fine-grained, high-grade, rapid-fire, phosphate-bound investment that provides a significantly longer working time and an incredibly smooth casting. The grains are so fine that there is no need for any form of debubbler or paint to break the surface tension while investing.

Post-investing, it is highly recommended to use the pressure vessel process, which reduces casting time significantly and raises the thermal shock value of the investment. By raising the thermal shock of the invested ring, the investment is considerably harder, and the ambient or entry temperature and heat rise could be elevated to shorten the total casting process time. This new and higher entry transition shortens the overall process and allows for a quicker casting, since the desired temperature for casting is reached more quickly. Once the frame is cast, it is allowed to cool and the ring is de-vested by tapping the button gently with a hammer. The casted frame is then sandblasted and put through the electrolytic process.

In order to fit the frame with the sprues on, first inspect the guide planes for any texture that would need to be removed. After that, adjust the clasps out and away from the undercuts while sitting the frame on the model without pressure. This shows any areas around the guide planes or under clasps that need trimming. If the areas that are tight are

trimmed, the casted frame usually drops down in less than 90 seconds. After fitting, the frame can then be trimmed, polished and high-shined as usual. Ultimately, check the bite, trim the rests and adjust the clasps prior to performing final quality controls.

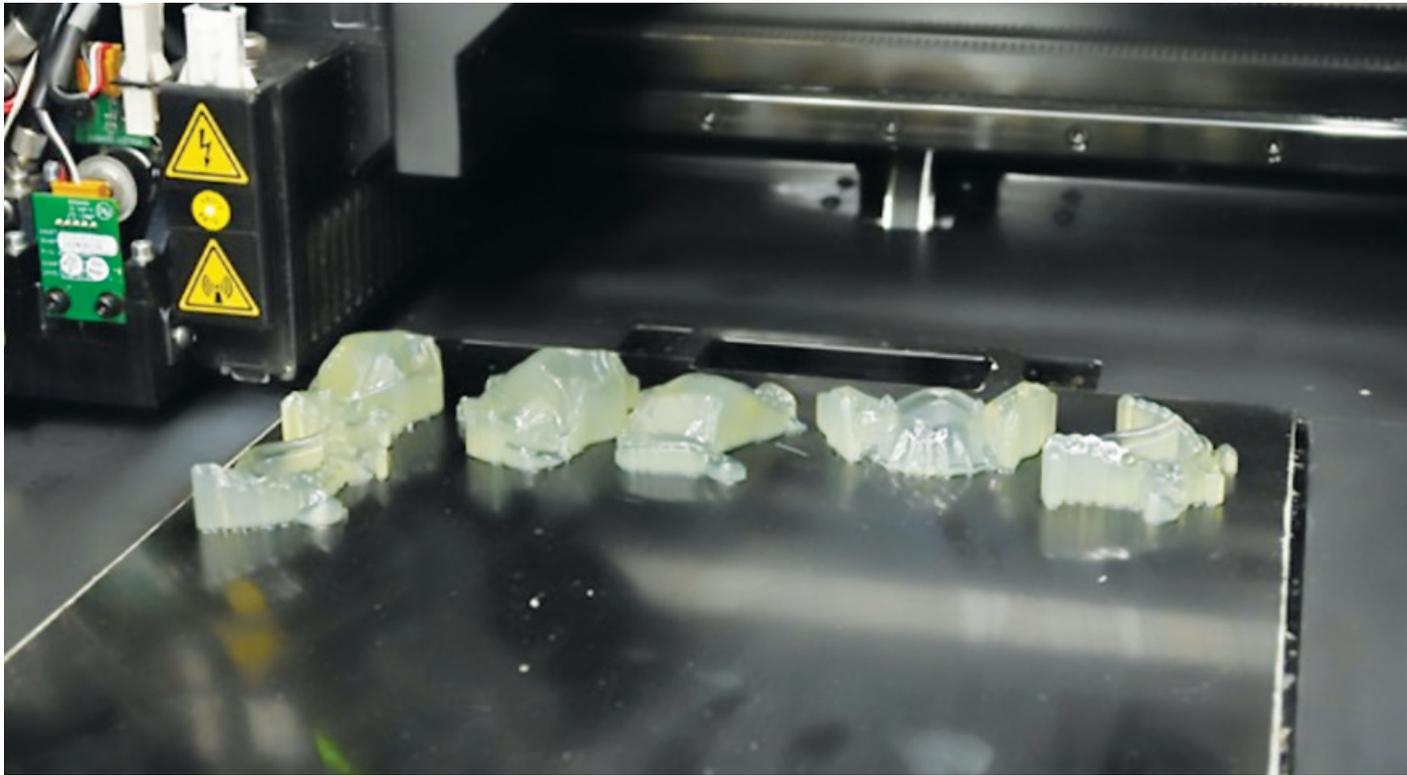
How Did PolyJet Compare to Traditional Prototyping Methods for Nobilium?

| METHOD | LEAD TIME |
|-------------------------|--------------------------|
| Traditional Prototyping | 7 hours |
| PolyJet Prototyping | 15 minutes |
| Savings | 6 hours 45 minutes (96%) |

An average technician's labor time of six to seven hours can be reduced to 15 minutes, offering faster production outputs, both in the design and manufacturing processes.

Conclusion

With the competitive dental environment becoming more production-driven, partnering with good technological solutions yields greater returns on investment (ROI), as well as enhanced viability and desirability for your business. Through this technology, cast partial denture frames via digital solutions can be produced with an improved level of accuracy at 16 microns, consistency and an enhanced level of production, creating a real benefit to the patient, dentist, employee and business at large.



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