

PEEK- A new material for CAD/CAM dentistry

By Terry Whitty



"The advantages of PEEK partial denture frameworks are many. It's strong and lightweight for improved patient comfort; digital design matches the patient's individual anatomy; and the metal-free denture framework is taste-neutral..."

With the introduction of computer designed and manufacturing techniques in dentistry, it has become possible to fabricate restorations, frameworks and appliances using modern biocompatible materials including alloys, ceramics and high-performance polymers. Many of these materials cannot be processed or can only be processed with great difficulty using conventional methods. One of these newer materials is the thermoplastic composite polymer known as PolyEther Ether Ketone or PEEK.

Metal-free restorations are becoming increasingly important in dentistry due to factors such as the increased aesthetic demands of the patient, legislation in some countries and possible material incompatibility. These days, it seems more patients want to avoid incorporation of a metallic material in the mouth and clinicians are following this trend too. Ceramic materials ideally meet the aesthetic requirements but also may have material or technical disadvantages in some cases.

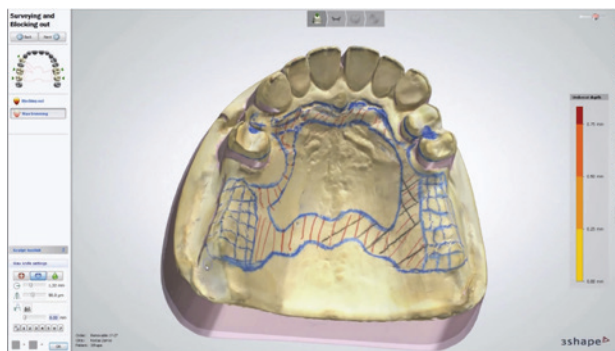


Figure 1. Scan from a 3Shape D900 colour scanner. This scanner has the ability to scan and reproduce drawn lines from a stone model.

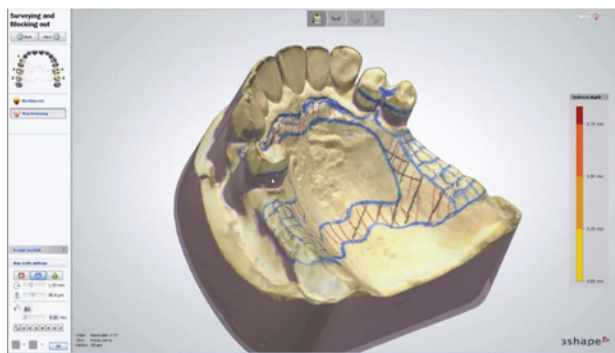


Figure 2. Using the 3Shape Partial Denture Designer, the digital model is surveyed, path of insertion is determined and undesirable undercuts are blocked out.

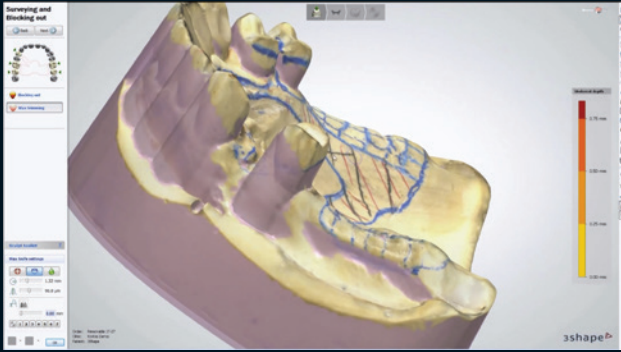


Figure 3. Blocking out of undercuts. Virtual wax can be shaped to the desired height of contour and undercut for clasps. Undesirable undercuts are blocked.

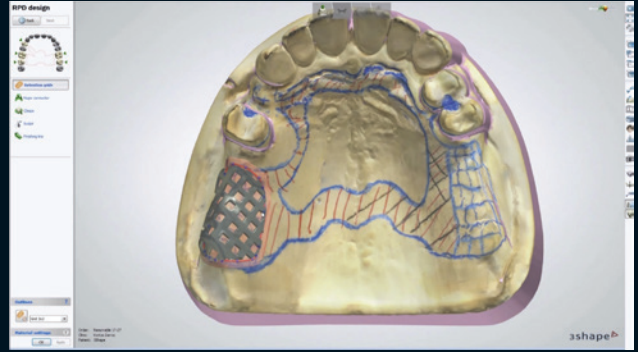


Figure 4. Retention grids are designed.

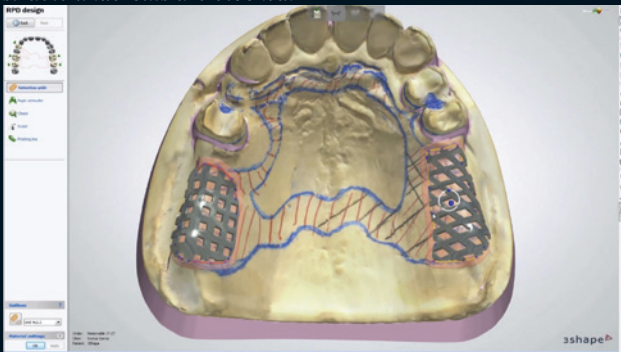


Figure 5. Various retention grid designs are available.

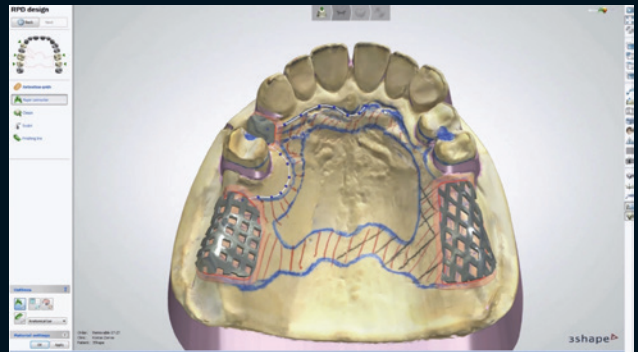


Figure 6. Tracing the spline for the major connector. A spline in this situation is a drawn curve on the 3D model.

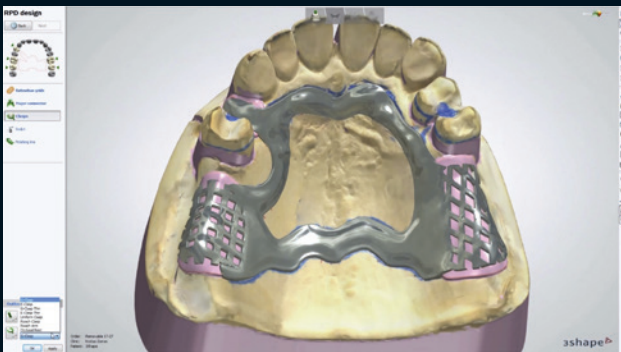


Figure 7. Rendering of the major connector framework.



Figure 8. Rest formation.

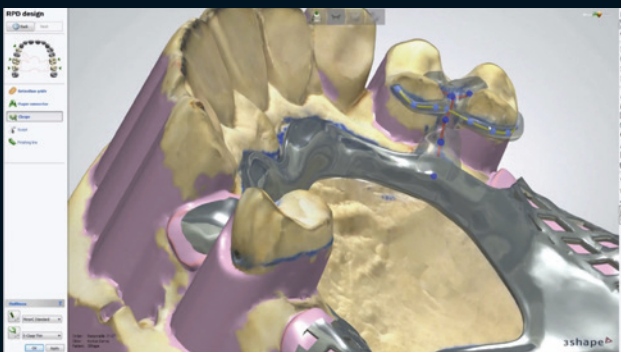


Figure 9. Clasp design.

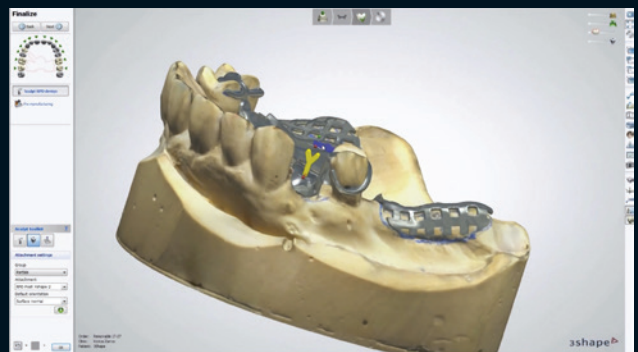


Figure 10. Support post design.

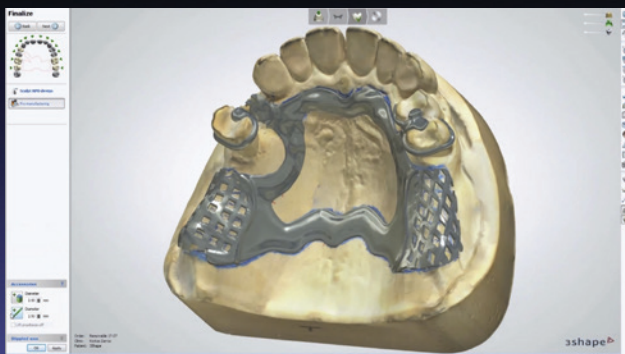


Figure 11. Finished 3D design.

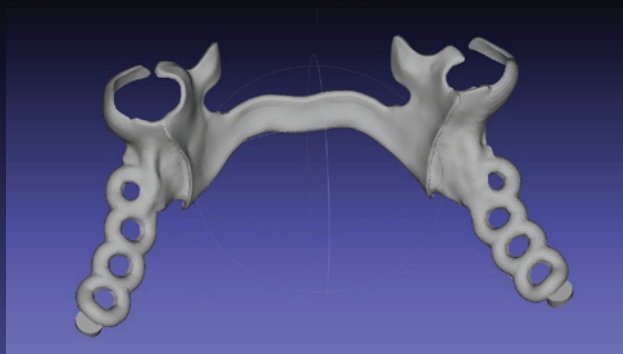


Figure 12. A 3D Designed framework opened in an inspection program and ready for milling.

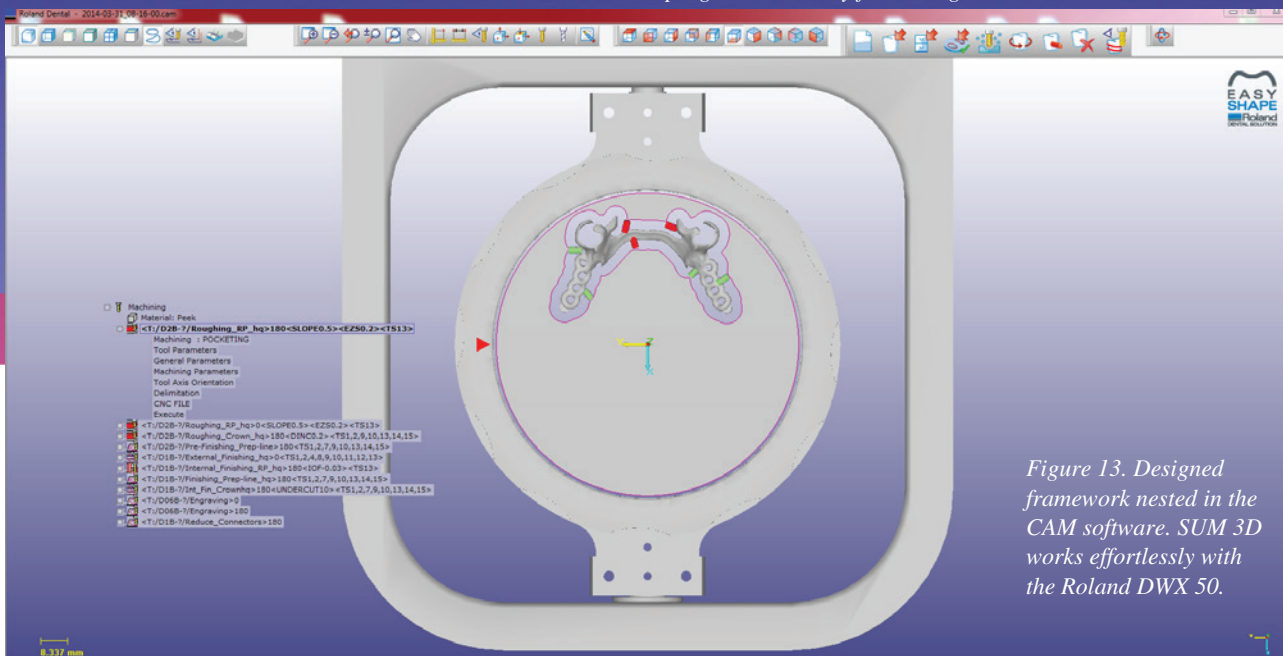


Figure 13. Designed framework nested in the CAM software. SUM 3D works effortlessly with the Roland DWX 50.



Figure 14. The Roland DWX 50 is a 5-axis machine more than capable of milling most materials. Perfect to mill PEEK!

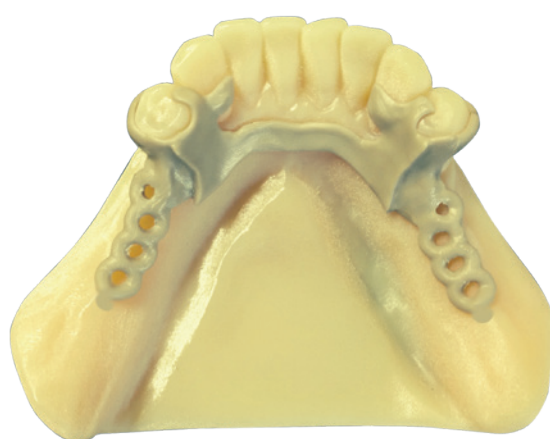


Figure 15. Milled framework from Roland DWX 50. NB: only the milling connectors have been trimmed. Surface finish is amazing.

Polyether ether ketone (PEEK) high-performance polymer has been used in industry for many years and has also proven successful in many areas of medicine. It is now also finding increased uses in dentistry as a direct result of CAD/CAM technology.

PEEK is characterised by excellent mechanical and chemical properties. In medicine, it has long been used for the preparation of different kinds of implants. Artificial cranial plates, components

of finger and knee joints or intervertebral bodies (spine implants) are just a few examples of the versatile use of the material in the area of long-term implantation. For several years, PEEK has also increasingly been applied in dentistry. Due to its combination of superior biocompatibility and ideal mechanical properties, the material is particularly attractive for dental restorations and it is ideal for CAD/CAM framework fabrication in prosthetic dentistry.

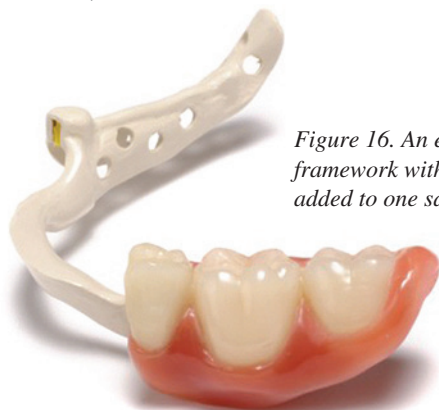


Figure 16. An example framework with teeth added to one saddle area.

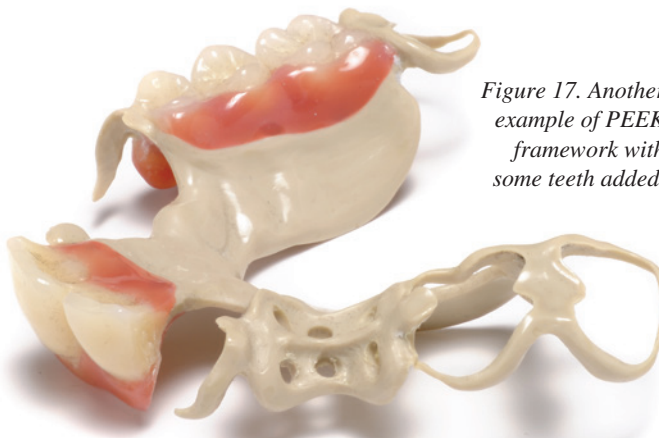


Figure 17. Another example of PEEK framework with some teeth added.



Figure 18. Full upper denture design over PEEK framework.



Figure 19. Various examples of PEEK frameworks.



In comparison to traditional materials previously used, PEEK has an abundance of advantages. It has a high strength to weight ratio, it has elastic properties similar to human bone, it has a zero corrosion rate, has extremely low water absorption and is radiolucent. Certain manufacturers can supply “filler free” material making it an ultra high purity material so this is the type ideal for dental use. Also in the past ten years, there has been no indications of allergic reactions to the material.

One notable dental brand of PEEK is JUVORA. Their ultra high purity “filler free” type of PEEK is unique in the marketplace and has been used in 4 million medical device implants. Juvora is a true unfilled pure form of PEEK and really does mill effortlessly with the Roland DWX 50 with SUM 3D CAM software already having a preset strategy to suit. If you are choosing a PEEK material go for the Juvora high purity unfilled disks.

One major advantage of a CAD/CAM fabricated framework is that the mechanical properties of the PEEK material are not adversely affected by the milling process as some materials can be, provided it is done in keeping with the manufacturer’s specification. Bridge frameworks milled from a high-grade, industrially manufactured block undergo no physical changes during the fabrication process and possess the same material/technical properties.

Uses for PEEK in dental technology include abutments, fixed prosthetic frameworks and removable partial denture frameworks including precision attachments.

Historically, most polymer-based partial denture frameworks tend to need bulk to attain a certain strength and can often be brittle or too flexible. Metal frameworks are often time consuming to produce or require expensive equipment such as Selective Laser Melting machinery when digitally manufactured.

This is not so with PEEK as it exhibits a perfect balance of the properties desirable to frameworks and can be milled very easily, especially with an affordable Roland DWX 50 milling machine.

The advantages to the patient when using a PEEK partial denture framework are many. It’s strong and lightweight for improved patient comfort; digital design matches the patient’s individual anatomy; the metal-free denture framework is a taste-neutral (no metal taste); has no thermal or electrical conductivity; is x-ray and scanner friendly; and is non-allergenic. PEEK frameworks are also shock absorbent during chewing; and have a high resistance to abrasion and decay.

In this article, Figures 1-15 follow the general workflow of a CAD designed and milled partial denture framework using a Roland DWX 50 Milling unit, SUM 3D CAM software and 3Shape CAD software. Figures 16-19 show what is possible. Enjoy the future!

About the author

Terry Whitty lectures nationally and internationally on a variety of dental technology and material science subjects and runs a busy laboratory in Sydney’s Eastern Suburbs, specialising in high tech dental manufacturing. Using the latest advances in intra- and extraoral scanning, CAD/CAM and 3D printing technologies, most specialties are covered including fixed and removable prosthetics, orthodontics and computer implant planning and guidance. He also specialises in the latest injection systems for traditional and CAD designed removable prosthetics and various associated dental appliances. His articles appear in various international journals. He can be contacted on (02) 9313-7971.