The evolution of implant restorative options has rapidly arrived at the point of additive fabrication technology for the development of Implant bar Substrates. Selective laser melting (SLM) is a process that uses 3D CAD data as a digital information source and energy in the form of a high powered laser beam (usually an ytterbium fiber laser) to create three-dimensional metal parts by fusing fine metallic powders together. What is called selective laser melting started at the Fraunhofer Institute ILT in Aachen, Germany.¹

The technology involves thin layers of atomized fine metal powder that are evenly distributed using a coating mechanism onto a metal substrate plate, that is fastened to an indexing table that moves in a vertical axis. The process is housed inside a chamber containing an atmosphere of either argon or nitrogen inert gas which prevents oxidation during the process. After each layer has been distributed, it is fused by selectively applying the laser energy to the powder surface. The intense laser energy permits welding of the particles to form solid metal. The process is repeated layer after layer until the part is complete.

Through this direct manufacturing process, the efficiency and dimensional adaptation of metal dental device fabrication is dramatically improved by elimination of the traditional wax pattern fabrication, investing and casting steps. The virtually unlimited design possibilities that can be accomplished with additive technology have proven to be possibly the...
The greatest advantage in dental applications. The need for intricate retention components in fixed detachable substrates is only achievable through this application.2

The process of selective laser melting for rapid prototyping of metal samples has been possible since 1995, but only recently has it reached the price point of affordability to the dental restorative market. It is still quite expensive and therefore feasible only in large centralized production facilities and the largest of laboratories.

The current CAM approach to fixed detachable suprastructure fabrication has served dentistry well as advancement from traditional lost wax, hand fabricated techniques. While this approach has proven to be extremely precise and provides reasonable support for the veneered acrylic resin and prosthetic teeth required of a fixed detachable/hybrid restoration, there are some concerns. Recent studies have identified potential issues with stress fractures of the prosthetic resin retaining the denture teeth. This is potentially due to the lack of adequate mechanical surface retention of the resin to the framework. Retentive surfaces are limited to areas of removed material during milling.3

Improved retention can be accomplished with the intricate surface retentive designs that are virtually unlimited with the SLM process.

The SLM Pearl design from Preat Corporation is an excellent example of this application. In fact, as of press time, it’s the only example because no one else in the industry is manufacturing selective laser melted bars for implant dentistry. However, we don’t expect it to stay this way as it has the potential to be a huge growth opportunity for our industry.

Preat Corporation’s Precision Implant Suprastructure Design and Manufacturing Center (PRISM) is dedicated to providing a full array of milled and SLM applications from titanium and cobalt chrome alloys designed to satisfy any restorative situation.

Laboratory Fabrication Workflow

Figure 2: Develop a soft tissue master cast from the impression.

Figure 3A: Develop a verification jig from VLC resin and metal provisional or impression cylinders. First, seat open tray impression copings on cast and apply appropriate separating medium to cast and abutments.

Figure 3B: Adapt VLC resin (Primosplint, VLC Nightguard material) to the abutments precisely splinting all cylinders and light cure. These materials are very accurate, and allow definitive shaping in the uncured state, cutting down significantly on finishing time.

Figure 3C: Finish and polish.

The use of VLC resin (Primosplint, Primotech) optimizes labor and materials costs making this a very productive process. It provides the best dimensional accuracy and post processing stability compared to conventional red methyl methacrylate materials commonly used in the past.
Develop a Screw Retained Occlusion Rim

**Figure 4:** Upon confirmation of cast accuracy, articulate casts and set prosthetic teeth for a screw retained wax try in.

**Figure 5:** Send the approved set up, master cast and prescription to Preat Corporation’s PRISM team for fabrication.

**Figure 6:** Upon receipt of the 3D image of prosthesis design from the PRISM team, suggest modification or accept from completion. Confirmation jig approval should eliminate the need for a metal try in.

**Figure 7:** For a fixed detachable prosthesis, transfer prosthetic teeth to fixed detachable substrate for a wax try in if requested.

**Figure 8:** At processing apply a suitable bonding agent and opaque layer to the fixed detachable substrate, such as the GC Gradia Bonding agent. Process resin with desired technique and finish to completion.
Figure 9A: For a bar retained overdenture restoration, the following steps should be taken. The generally accepted rationales for bar inclusion in implant edentulous restorations are:

1. To splint implants for improved support on fixtures placed in questionable bone (typical in the maxillae).4
2. To spread the retentive elements out to a more stable prosthesis supporting position.

A wide variety of designs are available for implant bar supported removable overdentures. While almost any design is applicable with the mandible due to the typical significant vertical resorption pattern, careful consideration of space limitations must be applied to the maxillary arch. The maxillae resorbs palatally and less vertically leaving limited restorative space for retentive elements. The average upper arch has approximately 5mm–7mm from the tissue to the occlusal surface of the posterior prosthetic teeth. We need at least 3mm for acrylic teeth for adequate functional strength. This leaves a 4mm working space for the bar and attachments. Therefore, stacking the attachments on top of the bar is not an option, leading us to design these cases with extracoronal retainers placed at the same 4mm vertical height as the retaining bar.

Figure 9B: Mandibular example of attachment positioning to lower vertical height.

Figure 10: A second anatomical consideration is often overlooked in the treatment planning of fully edentulous maxillary implant cases. Due to the previously mentioned resorption pattern of the maxillae, the required position of the anterior teeth in the prosthesis places them 5mm–7mm labial to the incisive papillae. The need for implants to be placed in the center of the current ridge position combined with the labial position of the anterior teeth leads to an undesired bulk behind the incisors in the prosthesis.5

Therefore the placement of implants between Nos. 6 and 11 should be avoided in cases planned for removable implant supported overdentures. Ideally, implants are placed most mesially in the sites of the first bicuspid with one to two additional implants posterior to that site. The number of fixtures is dictated by the quality of bone at the surgical sites. Due to the traditionally poor quality of bone in this region, three implants on each side is the common treatment. Bilateral implant bars with extracoronal attachments prove to best fulfill the functional and phonetic requirements of a successful case.

Figure 11: It is ideal for maxillary cases that a RPD horseshoe major connector framework be incorporated into the final prosthesis at this stage. This provides the patient with the desired clinical outcome of an open palate with optimum comfort and strength for long-term service without concern for the acrylic withstanding the excessive load of occlusion from a patient with no proprioception.
Figure 12: Process the case to completion with an emphasis on minimal flange contours only replacing the resorbed osseous structures. This is possible when an adequate attachment design eliminates the need for flanges as a retentive component of the prosthesis.

It is interesting that in a sense, we are virtually back where we began when Dr. Branemark introduced the original restorative design for his root form implant. At that introduction we were limited to mandibular fully edentulous arches, fabricated in the hybrid style with prosthetic denture teeth supported by a cast noble alloy substrate, as that was the application used to accomplish the supporting research in Sweden.6 We now are limited only by sound design principles and our imagination as we continue to open new doors with advancing dental technology and materials. JDT

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