State of the Art
Press) bonded to enamel (Figs 34a to 34d). At the end of treatment, the patient was provided with an occlusal night guard (Fig 35a). Figures 35b to 35d show the final result after 18 months.

**CONCLUSION**

The use of minimally invasive indirect restorations for oral rehabilitation should be part of the armamentarium of every restorative dentist and prosthodontist. When properly executed, the techniques described in this paper provide successful full-mouth rehabilitations with minimal damage to the natural tooth structures.

**REFERENCES**


The Anatomical Shell Technique: Mimicking Nature

Paulo Kano, DDS, MSc¹
Luiz Narciso Baratieri, DDS, MSc, PhD²
Rafael Decúrcio, DDS, MSc, PhD³
Sillas Duarte, Jr, DDS, MS, PhD⁴
Pricila Saito, DDS⁵
Jonathan L. Ferencz, DDS⁶
Nelson R.F.A. Silva, DDS, MSc, PhD⁶

¹Visiting Professor, Federal University of Santa Catarina, Florianópolis; Private Practice, São Paulo, Brazil.
²Professor and Chair, Department of Dentistry, Federal University of Santa Catarina, Florianópolis, Brazil.
³Professor of Operative Dentistry, Residency Course ABO Gionia; President of ABO, Goiania, Brazil.
⁴Associate Professor and Chair, Division of Restorative Sciences, Ostrol School of Dentistry, University of Southern California, Los Angeles, California, USA.
⁵Clinical Professor, New York University College of Dentistry; Private Practice, New York, New York, USA.
⁶Adjunct Professor, Department of Restorative Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil.

Correspondence to: Dr Paulo Kano, Rua das Pitomeiras, 126 Jabaquara, São Paulo, SP 04321-160, Brazil.
Email: ipkano@gmail.com
The anatomical shell technique (AST) developed by Kano and collaborators\(^1\) was designed to address the lack of predictability regarding the final esthetic outcome of restorations, particularly when computer-aided design/computer-aided manufacturing (CAD/CAM) is used. This technique involves a concept in which flowable composite resins shells are used as temporary laminates to guide the fabrication of the final restorations and to predict the final esthetic and morphological outcomes.

One of the challenges in esthetic dentistry is achieving natural and lifelike surface textures.\(^2\) Surface texture directly influences the value, color saturation, and zones of light reflection and absorption. An anterior restoration that does not exhibit surface texture and luster comparable to the adjacent natural teeth will immediately appear out of place, particularly when the surface of the surrounding dentition is complex or heavily textured. The natural tooth’s surface is composed of horizontal and vertical concavities and convexities that vary in complexity and intensity from tooth to tooth. Achieving the desired level of esthetics in restorations is rarely possible when these features are not precisely replicated.

The ability to observe and replicate the surface texture and luster to create an anterior restoration that is indistinguishable from adjacent natural teeth typically requires a highly skilled dentist and/or laboratory technician. However, with AST, both professionals can mimic texture from adjacent natural teeth surfaces and use a milling machine to reproduce it. Therefore, AST seems to be a powerful concept for esthetic outcomes and provides a broad spectrum of opportunities to develop different treatment modalities mimicking nature. This article describes a clinical scenario in which the morphology and texture of a patient’s natural dentition was copied and AST used to align and restore the esthetic appearance of the patient with the use of dental CAD/CAM technology.\(^3\)

**DIGITAL ESTHETIC PLANNING**

There is no doubt that excellence in esthetic dentistry can only be achieved with thorough treatment planning, including imaging and videos analyzed with reference lines to better plan and predict the final esthetic outcome. Several principles for treatment planning using images must be followed to achieve successful treatment. Digital smile design (DSD), as described by Coachman and collaborators,\(^4\) has definitely changed the way esthetics can be seen. However, more laborious digital treatment-planning concepts are desirable, such as the digital esthetic planning (DEP) illustrated in this case.

**Case Presentation Using DEP and AST to Mimic Nature**

The patient in this case wished to improve her smile (Figs 1 and 2). Orthodontic treatment was initially proposed, but the patient preferred a more immediate solution. AST was therefore employed.

In most cases, a simple intraoral evaluation is not enough to plan and execute a treatment. Facial reference lines must be constructed to correct the alignment of the teeth. To accomplish this, it is necessary to make a close-up image from the original full-face photograph taken.

Figures 3 to 14 show how DEP can be used as a planning tool for AST (Figs 15 to 20) to optimize the final esthetic treatment outcome (Fig 21).
Fig 1 Initial photograph of the patient for treatment planning.

Figs 2a to 2d Close-up photographs of the smile architecture at different angles and intraoral view of the maxillary teeth. Note enamel hypoplasia (amelogenesis imperfecta) on the facial aspect of the central incisors.
Fig 3  The initial step for adequate DEP involves the evaluation of the proportion of facial thirds, in which a frontal photograph of the patient in rest position is taken and three horizontal lines are defined: (1) the top of the head, (2) interpupillary line, and (3) below the chin. In this particular case, the lines divide the face into two equal sections measuring 11.5 cm.

Fig 4  With the same photograph, one must also evaluate the proportions between the line at the top of the head, the ofriac line (through the eyebrows), the interalar line, and the chin line. In this case the lines further divide the face into three sections, each measuring 6.3 cm.

Figs 5a and 5b  After the evaluation of the horizontal lines, the vertical references are placed. This creates symmetry between the left and right sides of the face. The reference lines should coincide in most cases with the midline and external limits of the face, with or without smile.
Fig 6  Photograph of the patient with a broad smile. By transferring the patient's left-side reference line to the right side, the ideal position of the right canine is defined. The midline of the face (glabella) is coincident with the dental midline and lip tubercle. The bridge of the nose, philtrum, and chin are not coincident, with deviation to the right of the patient.

Fig 7  Distance from the labial commissures (red lines) to the midline of the face (yellow line) coincides on both sides. Midline of the mandibular incisor does not coincide with the midline of the face (blue line) but does coincide with the bridge of the nose, philtrum, and chin.

Fig 8  Distance between the patient's midline and the tips of the mesiobuccal cusps of the maxillary first molars is coincident. The incisal edges of the central incisors have mild discrepancy. There is less gingivocisal distance of the left central incisor compared with the right central incisor.

Figs 9a and 9b  Tooth proportion analysis indicates a difference in the length and width of the teeth.
Figs 10a and 10b  Drawing a curve, symmetric and parallel to interpupillary line, across the maxillary arch in a frontal plane, allows one to observe that the central incisors are slightly short. The patient’s left posterior teeth are not touching the curve, also suggesting reduced length of these teeth. The labial commissure line is parallel to the interalar line and the interpupillary line. This means that the patient’s lips are in harmony with the face.

Fig 11  By comparing the zenith of the gingiva, the inferior border of the upper lip, and gingival line, a discrepancy in the gingival contour of the teeth is seen, suggesting the need for gingivoplasty.
Figs 12a to 12c Note that when the patient has a discrete smile, one can see a greater alignment discrepancy of the teeth, which gives the impression of crowded teeth. However, when the patient smiles showing the gingival tissue and mandibular teeth, that alignment discrepancy tends to disappear. The lateral incisors are visibly facially positioned and have accentuated distorotation. That discrepancy is quite visible on the anterior teeth as shown in the previous images. Both central incisors are lingually positioned, but this inclination is more exaggerated in the left tooth. The right central incisor is tilted left in relation to the midline of the face and tilted to the mesial. The canines and posterior teeth are also lingually positioned, resulting in an increase of the dimension of the buccal corridor.
Figs 13a to 13d These profile photographs give a better perspective of the buccolingual aspect of the teeth. Through observation of the teeth angulation, one can see the mesial aspects of the central and lateral incisors, where there is an anteroposterior posterior discrepancy of the referred teeth. Note that the discrepancy becomes more evident when a white line is placed along the incisal edges of the teeth. The central incisors are more lingually positioned (suggesting Angle Class II, Division 2) and the two lateral incisors more facially positioned. Note the better alignment of the canine and premolars in Fig 13d.
Fig 14  The Digital Esthetic Planning is completed. The teeth were cropped from the original image and repositioned over the same image to correct the teeth angulation (the cropped portion was reshaped to the appropriate dimension). This procedure is known as a cloning or mirroring. Distal lines were created to show the teeth inclination. The natural teeth show discrepancy in the angles. Digitally, the teeth were repositioned more facially and corrections in the position were made. Note that the angles are equal for the teeth of the same group (in yellow). The lateral incisors present a slight discrepancy to give a certain naturalness.

Figs 15a and 15b  Impression key was taken from the original dentition using vinyl polysiloxane material, and flowable composite resin shells were fabricated according to the manufacturer's instructions regarding light-curing time and unit power for complete polymerization.
Figs 16a to 16k  Sequence of images showing the misalignment of the two lateral incisors. VPS matrix (Virtual, Ivoclar Vivadent, Schaan, Liechtenstein) was fabricated to be used as a guide during the initial preparation reduction.
Figs 17a to 17h AST usually involves the immediate placement of the shells in the patient’s mouth. In this case, however, a stone cast was obtained after the alignment of the two lateral incisors. It was performed to allow better positioning of the shells.
Figs 18a and 18b  Resin composite shells in place fixed with flowable composite without enamel conditioning and bonding. Note the anatomical detail of the incisal edges of the central incisors.
Figs 19a to 19e After resin composite shells were properly positioned, reflecting powder (Sirona, Long Island City, New York, USA) was applied and the “mock-up” scanned. Next, the anatomical shells were removed and minimally invasive preparations were performed, powdered, and scanned. The Biocopy (CEREC, Sirona) process was used to merge the two scanned files. Restorations were then fabricated by a CEREC INLab Unit (Sirona). Each veneer was fabricated using a multicolor CAD lithium disilicate glass ceramic (IPS Empress CAD, Multi BL 3, Ivoclar Vivadent).
Figs 20a and 20b Try-in step before final cementation. Note the healthy gingival tissues and the morphology obtained from the copy of the patient's natural dentition.
Figs 21a to 21e: Final photographs. Note the surface texture and morphology delivered by the CAD/CAM milling unit using AST to produce an extremely pleasing esthetic result.
REMARKS

The clinical case presented illustrates a simple way to fabricate esthetic restorations that mimic natural tooth shape and surface texture using AST. There is no doubt that the successful result is also due to the detailed digital esthetic planning employed. The decision to treat cases like this without using an orthodontic approach is always controversial. However, when accepted by the patient, the use of minimally invasive esthetic veneers also can be a very useful and predictable treatment modality.

REFERENCES