Trials@uspto.gov
571-272-7822

Paper 7
Date: July 12, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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DENTAL IMAGING TECHNOLOGIES CORPORATION,
Petitioner,

v.

3SHAPE A/S,
Patent Owner.

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IPR2023-00400
Patent 10,695,151 B2

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Before HUBERT C. LORIN, FRANCES L. IPPOLITO, and MICHELLE N. WORMMEESTER, *Administrative Patent Judges.*

LORIN, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
*35 U.S.C. § 314*

# I. INTRODUCTION

## *A. Background*

Dental Imaging Technologies Corporation ("Petitioner") filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 1–3, 6, 7, and 9–17 of U.S. Patent No. 10,695,151 B2 (Ex. 1001, "the '151 patent"). 3Shape A/S ("Patent Owner") filed a Preliminary Response (Paper 5, "Prelim. Resp.").

We have authority under 35 U.S.C. § 314, which provides that an *inter partes* review may not be instituted unless the information presented in the Petition and the Preliminary Response shows that "there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314(a) (2018).

After considering the Petition, the Preliminary Response, and the evidence of record, we deny Petitioner's request to institute an *inter partes* review as to the challenged claims of the '151 patent on the grounds of unpatentability presented.

## *B. Related Proceedings*

Petitioner indicates that the '151 patent is asserted in pending district court litigation styled *3Shape A/S v. Carestream Dental LLC et al.*, Civil No. 1:22-cv-01829 (N.D. Ga.). Pet. 71. Petitioner indicates that the Georgia district court litigation "was transferred from the Western District of Texas and was previously styled as *3Shape A/S v. Carestream Dental LLC*, Civil No. 6:21-cv-01110 (W.D. Tex.), filed October 26, 2021." *Id.*

Petitioner indicates that the ’151 patent is also the subject of pending district court litigation in *3Shape A/S v. Medit Corporation*, Civil No. 6:22-cv-00443 (W.D. Tex.), filed May 2, 2022. Pet. 71.[1]

Patent Owner, in its Mandatory Notices, identifies the same district court litigations as Petitioner. Paper 3, 1. Patent Owner also makes us aware of other Office proceedings involving U.S. Patent Nos. 11,076,146, 10,097,815, and 10,349,042 related to the ’151 patent. *Id.*

*C. Real Parties in Interest*

Petitioner identifies “DITC” and “Carestream Dental LLC” as real parties in interest. Pet. 71. Patent Owner identifies “3SHAPE A/S” as the real party in interest. Paper 3, 1.

*D. The ’151 Patent (Ex. 1001)*

*1. Disclosure*

The ’151 patent, titled “Detecting Tooth Shade,” “relates to methods and a user interfaces for determining the shade of a patient’s tooth or teeth and for utilizing the determined tooth shades for designing and manufacturing dental restorations.” Ex. 1001, code (54), 1:19:22. The ’151 patent explains that “[w]hen designing and manufacturing a dental restoration for a patient, such as a crown or a bridge restoration, it is advantageous that both the shape and shade of the manufactured restoration is adapted to the patient’s natural teeth surrounding the restoration.” *Id.* at 1:23–27.

[1] The Petition refers to “the ’146 patent” rather than the ’151 patent at issue in this proceeding. This appears to be a typographical error.

The ’151 patent explains that “[i]n many cases, the dental restoration is manufactured with a shade profile where the shade differs from the incisal edge towards cervical end of the restoration.” Ex. 1001 at 2:57–59. The ’151 patent describes embodiments that allow “the operator to determine tooth shade values for several points on the tooth such that a shade profile can be determined for the dental restoration.” *Id.* at 2:59–62. The ’151 patent discloses a method for determining shade of a patient’s tooth that includes obtaining a digital 3D representation of the tooth. *Id.* at 2:6–8. “[T]he digital 3D representation comprises shape data and texture data for the tooth.” *Id.* at 2:9–10.

Figure 7A, reproduced below, depicts a schematic of intra-oral scanning according to an embodiment of the ’151 patent. Ex. 1001, 15:50–51.

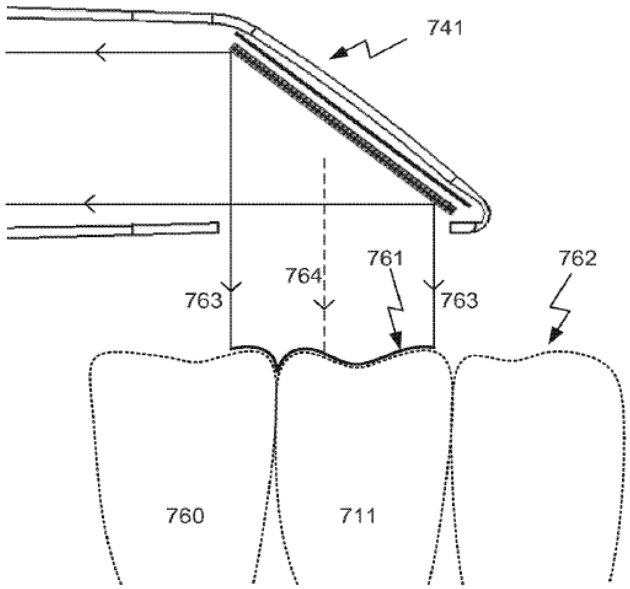



Figure 7A of the ’151 patent depicts a cross-sectional view of scanner 741 and teeth 711, 760. Ex. 1001, 16:10–13.

The ’151 patent explains that scanner 741 “is held in one position relative to” teeth 711, 760 “while recording a sequence of 2D images for one sub-scan.” Ex. 1001, 16:10–14. Full line 761 represents the Field of View of the scanner and “is determined by the light source, the optical components and the image sensor of the scanner.” *Id.* at 16:15–18. As shown in Figure 7A, “Field of View 761 covers part of the surface of the tooth 711 and part of the surface of the neighbor tooth 760.” *Id.* at 16:19–21. “The generated digital 3D representation can thus also contain data for the neighbor teeth.” *Id.* at 16:21–22. In Figure 7A, scanner 741 “is arranged such that the acquired sub-scan comprises shape and color information for the incisal edge 762 of the teeth.” *Id.* at 16:26–28. Probe light rays 763 from the scanner correspond to the perimeter of the Field of View and “define the optical path 764 of the scanner probe light at the tooth 711.” *Id.* at 16:28–32. The ’151 patent further describes that a “digital 3D representation of the tooth can be generated by combining sub-scans acquired from different orientations relative to the teeth, e.g. by sub-scan registration.” *Id.* at 16:33–35.

*2. Claims 1–3, 6, 7, and 9–17*

Petitioner challenges claims 1–3, 6, 7, and 9–17. Claims 1, 13, and 14 are independent claims. Claims 2, 3, 6, 7, and 9–12 and claims 15–17 depend from claims 1 and 14, respectively.

Claim 1 is reproduced below with bracketing added to assist in referring to the claim elements.

1. [preamble][2] A method for determining shade of a patient's tooth, wherein the method comprises:

1[a] obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data and texture data for the tooth; and

1[b] determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values,

1[c] wherein the method comprises deriving a certainty score expressing the certainty of the determined tooth shade value.

Ex. 1001, 21:28–40.

*E. Asserted References and Testimonial Evidence*

Petitioner relies on the following references:

| Name | Reference | Ex. No. |
|---|---|---|
| Babayoff | U.S. Patent US 7,698,068 B2, issued Apr. 13, 2010. | 1105 |
| Chu | Dental color matching instruments and systems. Review of clinical and research aspects. Journal of Dentistry, 38 Supp 2: e2-16, published Dec. 2010. | 1106 |
| Graham | U.S. Patent Publication No. 2005/0074718, published Apr. 7, 2005. | 1107 |
| Inglese | U.S. Patent Publication No. 2010/0201986, published Aug. 12, 2010. | 1109 |
| Nathaniel | U.S. Patent Publication No. 2011/0188726, published Aug. 4, 2011. | 1111 |

[2] Petitioner's designations to reference the elements of claim 1 are set forth in brackets. Pet. vi. Herein we refer to the elements of claim 1 using Petitioner's designations.

Petitioner also relies on the Declaration of Dr. Ioannis A. Kakadiaris (Ex. 1003, "Kakadiaris Decl.") as support for the various contentions.

*F. Asserted Grounds*

Petitioner asserts that claims 1–3, 6, 7, and 9–17 would have been unpatentable on the following grounds:

| Ground | Claim(s) Challenged | 35 U.S.C. § | Reference(s)/Basis |
|---|---|---|---|
| **I** | 1, 2, 6, 7, 9–15 | 103(a)[3] | Babayoff, Chu |
| **II** | 3 | 103(a) | Babayoff, Chu, Graham |
| **III** | 15–17 | 103(a) | Babayoff, Chu, Nathaniel |
| **IV** | 1, 2, 7, 9–15 | 103(a) | Babayoff, Inglese |
| **V** | 3 | 103(a) | Babayoff, Inglese, Graham |
| **VI** | 15–17 | 103(a) | Babayoff, Inglese, Nathaniel |

## II. ANALYSIS

*A. Principles of Law for Patentability*

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, "would have been obvious at the time the

[3] The Leahy-Smith America Invents Act, Pub. L. No. 112–29, 125 Stat. 284 (2011) ("AIA"), amended 35 U.S.C. §§ 102 and 103. Because the challenged claims of the '151 patent have an effective filing date before the effective date of the applicable AIA amendments, we refer to the pre-AIA version of 35 U.S.C. §§ 102 and 103 throughout this Decision.

invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden of persuasion does not shift to Patent Owner, except in limited circumstances not present here. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

*B. Level of Ordinary Skill in the Art*

Petitioner asserts a person of ordinary skill in the art "as of the effective filing date of the '151 patent would have at least a bachelor's degree in Computer Engineering, Computer Science, Computer Vision, or an equivalent field, as well as at least two years of imaging/image analysis experience, or alternatively, at least six years of comparable industry experience." Pet. 16 (citing Ex. 1003). Petitioner also asserts that a person of ordinary skill in the art "would have had experience with and knowledge

of 3D imaging systems and 3D modeling techniques." *Id.* (citing Ex. 1003, ¶ 18).

Patent Owner does not address Petitioner's characterization of a person of ordinary skill in the art at this stage of the proceeding. *See generally* Prelim. Resp.

Petitioner's proposed definition of a person of ordinary skill in the art appears reasonable, and we adopt that definition for our analysis in this decision.

Based on the complete record now before us, we adopt Petitioner's undisputed proposal as reasonable and consistent with the prior art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (the prior art may reflect an appropriate level of skill in the art).

*C. Claim Construction*

We determine that this Decision does not require construing any claim terms.

*D. Overview of the Prior Art References*

*1. Babayoff (Ex. 1105)*

Babayoff, titled "Method for Providing Data Associated with the Intraoral Cavity," relates to color three-dimensional numerical entities representative of tissues, particularly of the intraoral cavity" and more particularly, "the manipulation of such entities to provide data that is useful in procedures associated with the oral cavity, [e]specially dental surfaces thereof." Ex. 1105, code (54), 1:16–22. Figure 1 of Babayoff is reproduced below.

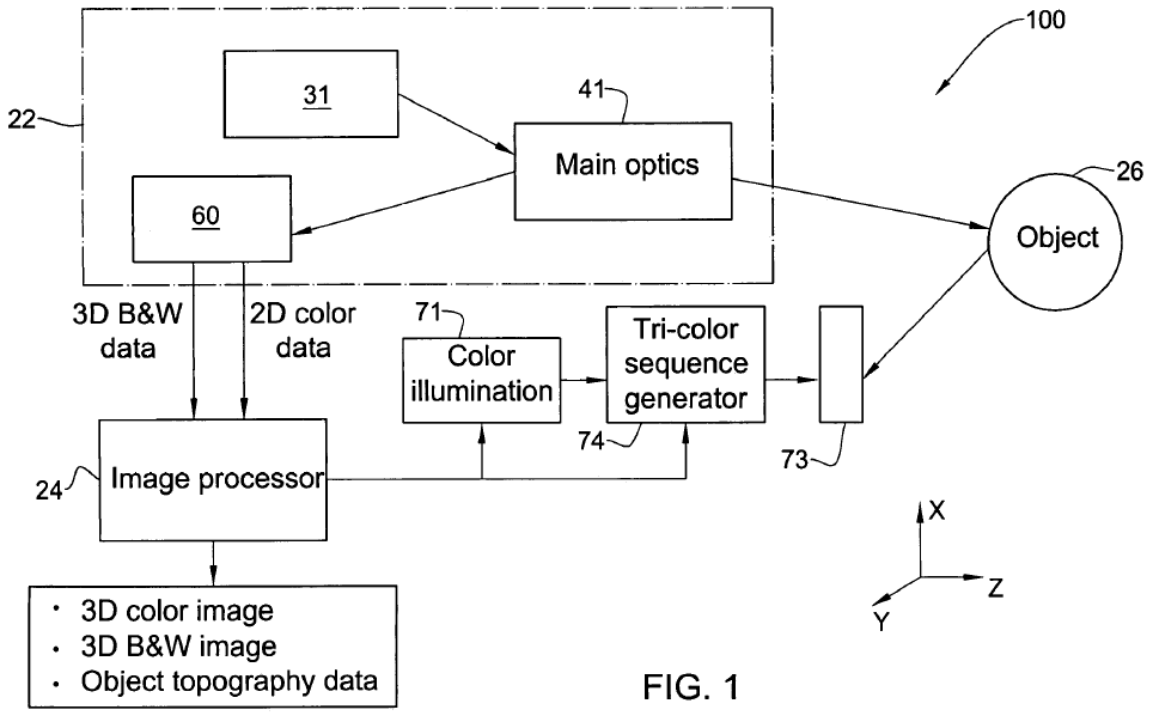



FIG. 1

Figure 1 of Babayoff illustrates the general relationship between the various elements of a device for providing a 3D color numerical entity. Ex. 1105, 8:25–29.

Babayoff's device 100 "comprises a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity, and is optically coupled to main optics 41 to provide depth Z values for an array range of X-Y points (according to a known frame of reference) along the surface of the object 26." Ex. 1105, 8:30–35. The '151 patent discloses that "[d]etection optics 60 comprises an image sensor, typically a CCD, that is preferably monochromatic to maximise the resolution of the device, and which typically defines the X-Y frame of reference." *Id.* at 8:35–38. "The detection optics 60 receives image data from the main optics 41 and the image processor 24 determines the depth Z values for each X-Y point illuminated on the object 26 based on this image data," and "a manipulable three-dimensional numerical entity E comprising the surface coordinates of

the object 26" is provided. The '151 patent discloses that device 100 "comprises color illuminating means, such as for example a tri-color sequence generator 74 for selectively illuminating the object 26 with suitable colors, typically Green, Red and Blue, and for each such monochromatic illumination, a two dimensional image of the object 26 is captured by the detection optics 60." *Id.* at 8:45–50.

*2. Chu (Ex. 1106)*

Chu is titled "Dental color matching instruments and systems. Review of clinical and research aspects." Ex. 1106, 2. Chu describes "[i]nstruments for clinical shade-matching" such as "spectrophotometers, colorimeters and imaging systems." *Id.* at 3. Chu explains that "[c]omplete tooth surface measurement [CTSM] devices give a color map of the gingival, body, and incisal shades for the fabrication of direct or indirect restorations." *Id.* at 4. According to Chu, "[t]hese systems give a virtual shade overlay of the proposed tab on the digital image on the computer screen of the tooth measured for visual reference and assessment by the clinician and/or technician." *Id.* Chu describes that "CTSM spectrophotometers, such as CrystalEye® and SpectroShade®, provide shade tab designation and the respective ΔE* values compared to shade tab values in memory." *Id.* Figure 1(d) of Chu is reproduced below.

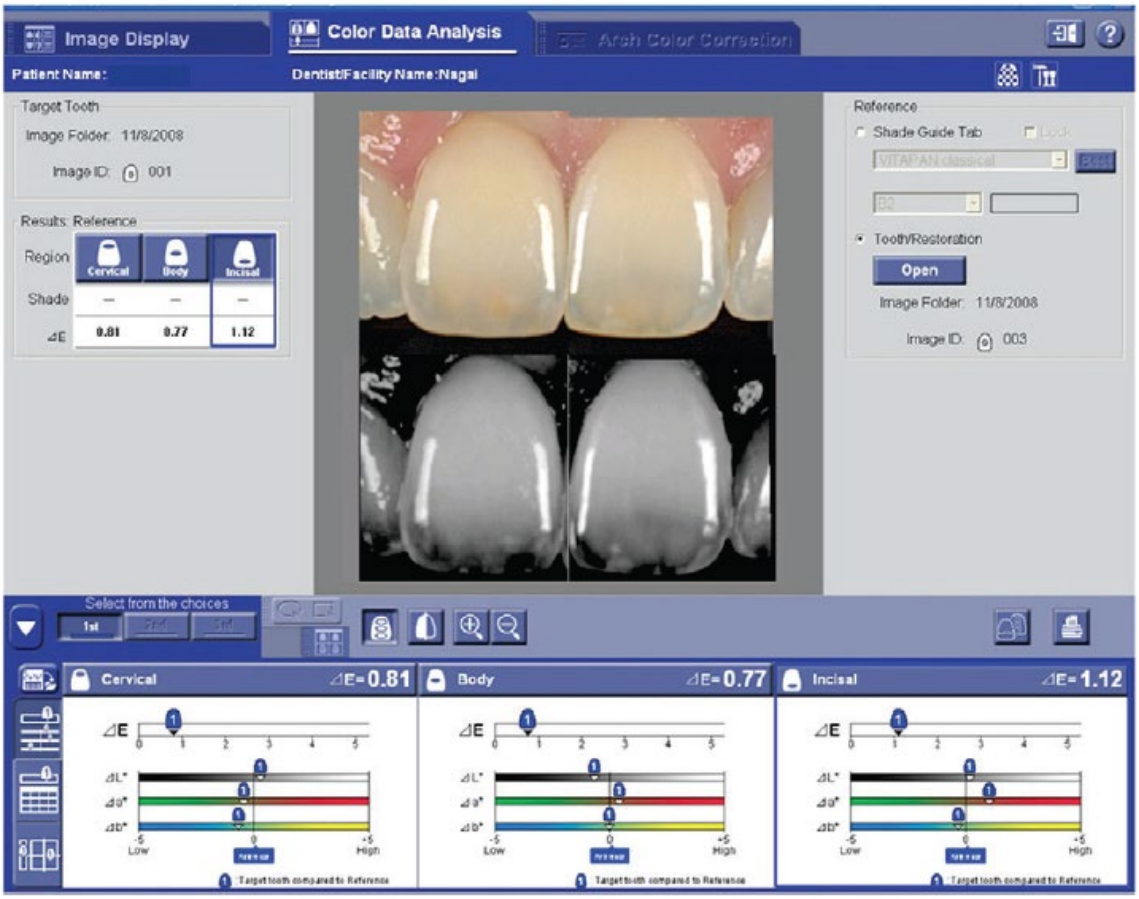



Figure 1(d) of Chu illustrates a clinical application of CrystalEye® spectrophotometer. Ex. 1106, 6.

As shown in Chu's Figure 1(d), CrystalEye® displays color difference ΔEs obtained in all 3 areas, namely cervical, body, and incisal. Ex. 1106, 6.

*3. Graham (Ex. 1107)*

Graham, titled "Tooth Shade Scan System and Method," "relates generally to image analysis, and more particularly, relates to tooth shade analysis tools." Ex. 1107, code (54), ¶ 1. Graham discloses tooth shade scan systems and methods "in which shade information for a restorative product for a patient's tooth is obtained." *Id.* ¶ 12. Figure 5 of Graham illustrates a graphical user interface in a shade analyzing system (*id.* at ¶ 22), and is reproduced below.

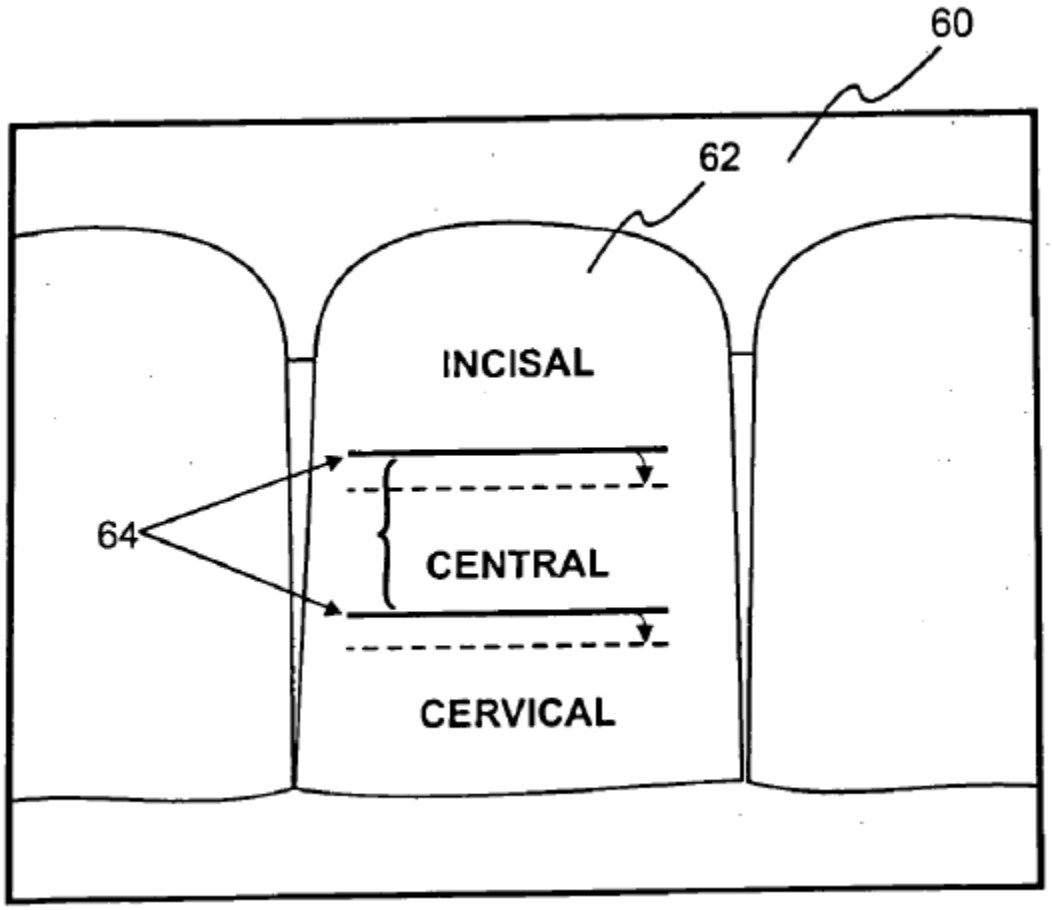



Figure 5 of Graham illustrates a graphical user interface in a shade analyzing system. Ex. 1107, ¶ 22.

As shown in Graham's Figure 1, "image 60 is an intraoral image of a patient's [mouth] that may be displayed on display equipment of a shade analyzing system." Ex. 1107, ¶ 47. The "object in image 60 that is currently of interest to the operator may be tooth 62." *Id.* "Lines 64 may be displayed over image 60" and divide tooth 62 into three regions, namely "incisal, central, and cervical regions." *Id.* "Movement and location of the lines 64 may be under operator control to allow the operator to selectively identify where the desired regions are located on the patient's tooth 62." *Id.* "Once the operator has moved lines 64 to a desired location, the operator

may make a selection to indicate to the shade analyzing system that the lines are in a location that divides tooth 62 into regions for which a database of tooth shade information exists," and "[i]n response, certain color characteristics for the regions may be captured from image 60 to generate discrete numerical values for the color characteristics for each region as a whole (e.g., RGB average values for each region)." *Id.* "Color characteristic values that are generated for the tooth from image information or sensed by imaging equipment may provide a discrete set of values that can be easily and quickly compared with information in the tooth shade database to identify appropriate tooth shades for each region of the patient's tooth." *Id.* ¶ 48.

*4. Inglese (Ex. 1109)*

Inglese, titled "Equipment and Method for Measuring Dental Shade," "relates to a device and a method for measuring dental shade," i.e., "a set of tooth characteristics that aim to establish the appearance of the tooth as faithfully as possible." Ex. 1109, code (54), ¶ 1. Inglese describes that "dental shade" includes "tooth color, but can also include other parameters such as the tooth tone, its transparency or surface condition, etc." *Id.* Inglese discloses a dental shade measuring device comprising "illumination means for successively illuminating at least one part of a tooth with light of various spectral ranges" (*id.* ¶ 12), "at least one monochrome sensor sensitive to intensity of light coming from said tooth part" (*id.* ¶ 13), "means for converting the measurement signals corresponding to said tooth part, into the coordinates of a measurement point" (*id.* ¶ 14), and "automatic search means, for the tooth part, for automatically searching a shade corresponding to the reference point closest to the measurement point, in the shade space"

(*id.* ¶ 15). Figure 5 of Inglese "illustrates the establishment of a tooth shade based on the measurement signal converted into a point of a shade space," (*id.* ¶ 76) and is reproduced below.

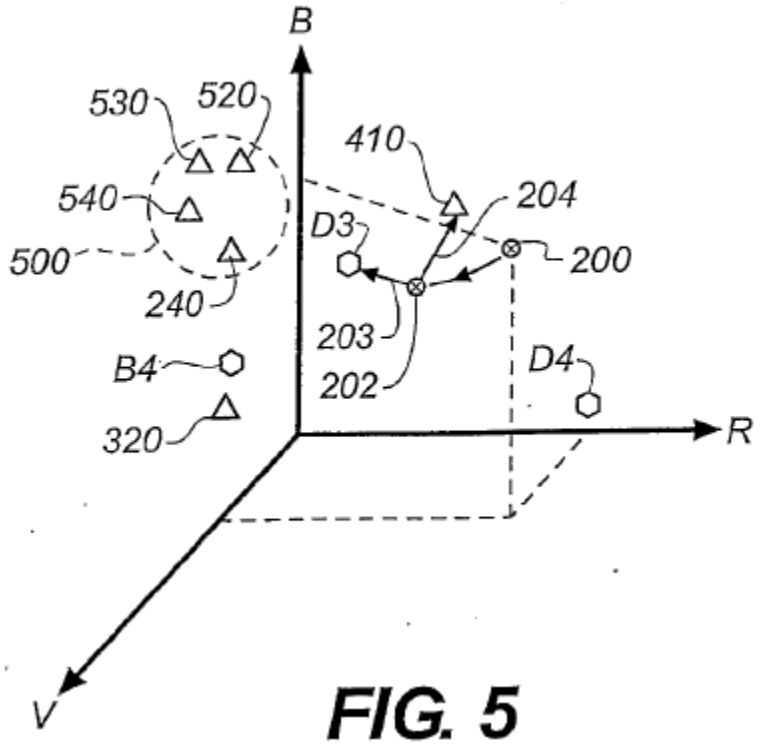



Figure 5 of Inglese "illustrates the establishment of a tooth shade based on the measurement signal converted into a point of a shade space." Ex. 1109, ¶ 76.

Figure 5 "shows a three dimensional shade space R, G, B." Ex. 1109, ¶ 78. "These dimensions correspond, for example, to the colors of three light sources, red, green and blue, of the illumination means." *Id.* "The measurement signal obtained in response to an illumination in a given spectral range, i.e. with a given color, is converted into a digital value, or code, by the analog-digital converter." *Id.* ¶ 79.

*5. Nathaniel (Ex. 1111)*

Nathaniel, titled "Method and System for Stitching Multiple Images into a Panoramic Image," relates "to the field of medical radiation based

imaging" and, more specifically, "relates to the stitching or combining of several images into one panoramic image." Ex. 1111, code (54), ¶ 1. Nathaniel describes "a method and system for generating a panoramic image based on a set of partially overlapping images, such as those produced by a radiation-based imaging device or system." *Id.* ¶ 24.

*E. Ground I—Obviousness over Babayoff and Chu*

Petitioner challenges claims 1, 2, 6, 7, and 9–15 as unpatentable under 35 U.S.C. § 103(a) over Babayoff and Chu. Pet. 17–45.

*1. Claim 1*

Claim 1 is drawn to "[a] method for determining shade of a patient's tooth" comprising, *inter alia*, (1[b]) "determining a tooth shade value for at least one point on the tooth based on [] texture data of [a] corresponding point of [a] digital 3D representation and on known texture values of one or more reference tooth shade values," (1[a]) "where the digital 3D representation comprises shape data and texture data for the tooth." Ex. 1001, 21:33–37, 30–32.

Petitioner contends that "Babayoff in combination with Chu satisfies these limitations of claim 1." Pet. 20 (citing Ex. 1003, ¶¶ 80–92).

Petitioner contends that Babayoff "discloses obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data (x, y, and z points) and texture data (color c) for the tooth." Pet. 20 (discussed at *id*. 17–20).

However, according to Petitioner, Babayoff does not teach determining a tooth shade *value* as claimed (*i.e.*, 1[b]). "[I]t is not apparent that Babayoff discloses [(1[b])] determining a tooth shade value for at least one point on the tooth based on the color data c of the corresponding point of

the digital 3D representation and on known color values of one or more reference tooth shade values." Pet. 21. Rather, "Babayoff discloses algorithmically determining tooth color based on surrounding teeth." *Id*. at 26.

> The desired shade for the prosthetic is determined according to a set of rules (algorithmically), or manually by the user, and involves choosing one or more teeth of the patient as a reference, referred to as data sets $I_{p1'}$. [Ex. 1105], 26:37-61. The data from these data sets, $I_{p1'}$ are then analyzed and used to create a color map for the prosthesis or restoration. *Id*., 26:62–27:29; see also FIG. 19.

*Id*. at 21.

Petitioner asserts Chu teaches determining a tooth shade *value* per 1(b). Pet. 21. According to Petitioner, "Chu teaches automatically comparing the color data to known color values of reference tooth shade values from a shade guide." *Id*. at 28 (citing Ex. 1003 ¶ 92).

Petitioner asserts that a POSA "would have been able to replace the shade matching function [*i.e*., determining tooth color based on surrounding teeth] in Babayoff with the shade matching function [*i.e*., comparing the color data to known color values of reference tooth shade values from a shade guide] as taught by Chu" and thereby reach a method for determining shade of a patient's tooth comprising "determining a tooth shade value" (1(b]) as claimed. Pet. 29 (citing Ex. 1003 ¶ 92). Petitioner provides various reasons (*id*. at 26–29) that would motivate a POSA to make the modification, including "to create an in intraoral scanner that automatically determines a tooth shade value using the color data of the corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values" (*id*. at 27).

We are unpersuaded that Petitioner has provided sufficient articulated reasoning, with adequate rational underpinnings, explaining why an ordinary artisan would have considered replacing Babayoff's shade matching function with Chu's shade matching function with a reasonable expectation of successfully arriving at the claimed subject matter. "[T]here must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006); *see also KSR*, 550 U.S. at 418 ("To facilitate review, this analysis should be made explicit.")

Petitioner explains that "Babayoff discloses obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data (x, y, and z points) and texture data (color c) for the tooth." Pet. 20 (citing Ex. 1105, 26:8–27:62).

> In Babayoff, the manner of determining the shading of the prosthesis is based on the shading characteristics of at least one tooth of the patent. [Ex, 1005,] 26:8-30. Babayoff explains that after creation of numerical entity I (including shape data x, y, z, and texture data color c), shade information for a prosthesis can be obtained that makes it compatible with surrounding teeth. *Id*., 26:20-24. The desired shade for the prosthetic is determined according to a set of rules (algorithmically), or manually by the user, and involves choosing one or more teeth of the patient as a reference, referred to as data sets $I_{P1'}$. *Id*., 26:37–61. The data from these data sets, $I_{P1'}$ are then analyzed and used to create a color map for the prosthesis or restoration. *Id*., 26:62–27:29; *see* also FIG. 19.

*Id*. at 20–21.

Petitioner explains that Chu describes spectrophotometers, discussing Chu's application of *CrystalEye* and *SpectroShade* spectrophotometers in detail. Pet. 21–25. More specifically, Petitioner contends

> Chu notes that spectrophotometers, such as *CrystalEye*, "provide shade tab designation and the respective ΔE values compared to shade tab values in memory." [Ex. 1003 ¶ 92] Chu also identifies MHT's *SpectroShade* product as a digital camera/LED spectrophotometer combination, including an internal computer with analytical software, noting that the measurements of such devices "are frequently keyed to dental shade guides and converted to shade tab equivalent."

*see e.g.*, *id.* at 21.

Petitioner explains that both the *CrystalEye* and *SpectroShade* spectrophotometers provide shade matching through "color comparisons between the measured color data and the known color values of the reference tooth shade value." Pet. 22 (citing Ex. 1003 ¶ 85; referring to Petitioner's annotated version of Chu Figure 1(d) (depicting an application of the *CrystalEye* spectrophotometer)), 24 (citing Ex. 1003 ¶ 88; referring to Petitioner's annotated version of Chu Figure 5(b) (depicting application of the *SpectroShade* spectrophotometer)), respectively.

Petitioner contends that the combination of Babayoff and Chu would have led a POSA to the claimed method because, *inter alia*, a POSA "would have been able to replace the shade matching function in Babayoff with the shade matching function as taught by Chu." Pet. 29 (citing Ex. 1003 ¶ 92).

Patent Owner disagrees, arguing that the combination of Babayoff and Chu would not have led a POSA to the claimed method because, *inter alia*, the Babayoff and Chu devices are "completely different." Prelim. Resp. 27. Patent Owner summarizes some of the differences:

> Babayoff discloses obtaining a 3D model having color. The spectrophotometers in Chu provide 2D color data alone. The Babayoff device obtains color data for points on the tooth. The spectrophotometers in Chu obtain color data for areas on the

> tooth. The Babayoff device places the color data in the same frame of reference as the X-Y array used for the 3D model. The spectrophotometers in Chu provide color for 2D image areas and there is no frame of reference for points in an X-Y array.

*Id*.

In our view, Patent Owner's characterization of the Babayoff and Chu devices as being very different devices is supported by the Babayoff and Inglese disclosures and consistent with Petitioner's own overview of Babayoff and Chu. *See* Pet. 7–10. For example, Babayoff teaches using a scanning device that "provid[es] at least one numerical entity that is representative of the three-dimensional surface geometry and color of at least part of the intra-oral cavity" (Ex. 1105, 7:53–56; *see* also Pet. 7). Chu uses, for example, a spectrophotometer to obtain "color difference ΔEs obtained in [] 3 areas" (Ex. 1106, e1; *see* also Pet. 10 (discussing Chu's *CrystalEye* device)).

Yet Petitioner does not adequately address the differences between the Babayoff and Chu devices and their objectives.

Petitioner asserts that "a POSA would have *expected* such a combination [i.e., Babayoff and Chu] to work for its intended purpose because Chu describes prior art imaging systems capable of determining tooth shade values from measured color data and known color values of one or more reference tooth shaped values. . . ." Pet. at 27 (citing Ex. 1003 ¶ 92) (emphasis added). Petitioner cites Dr. Kakadiaris's testimony in support of its assertion. *Id*. But Dr. Kakadiaris simply repeats, without factual support, Petitioner's assertion. *Cf. id*. and Ex. 1003 ¶ 92.

Dr. Kakadiaris's testimony does not provide any insight into why a POSA would have "expected" the combination of Babayoff and Chu to

achieve a method as claimed given that the Babayoff and Chu devices are designed to accomplish color matching in technically very different ways.

According to Petitioner, a POSA "would have been able to replace the shade matching function in Babayoff with the shade matching function as taught by Chu." Pet. 29 (citing Ex. 1003 ¶ 92). But how a POSA would have been able to replace the shade matching function in Babayoff with the shade matching function as taught by Chu and still arrive at the method claimed when they perform shade matching in technically very different ways is not adequately explained. As Patent Owner correctly points out, "[t]here is no mention [in Babayoff] of the use of a shade guide [as in Chu] to determine the shade of the prosthesis because the shade of the prosthesis is determined based on the selected teeth." Prelim. Resp. 25 (citing Ex. 1105, 26:39–56). And "Chu explicitly states that it obtains measurements for '3-5 mm diameter areas of the tooth being measured' not points of a digital 3D representation [as in Babayoff]. *Id*. at 26 (citing Ex. 1106, e4).

By not addressing the technical differences between the Babayoff and Chu devices, Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA would have been motivated to replace the shade matching function in Babayoff with the shade matching function as taught by Chu with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b].

For the above reasons, we are unpersuaded that the Petition establishes a reasonable likelihood that claim 1 is unpatentable over the combination of Babayoff and Chu.

*2. Claims 13 and 14*

Independent claims 13 and 14 recite the same limitation as 1[b] discussed above. *See* Ex. 1001, 22: 24–28 (claim 13), 43–47 (claim 14).

Petitioner's position that "Babayoff in combination with Chu satisfies these limitations [1[b]] of claim 1" (Pet. 21 (citing Ex. 1003 ¶¶ 81–92)) also applies to claims 13 and 14. *See id.* at 39, 42 (citing Ex. 1003 ¶ 115-119).

For the same reasons, therefore, as set forth above for the corresponding limitation of independent claim 1, the Petition does not establish a reasonable likelihood that claims 13 and 14 are unpatentable over Babayoff and Chu.

*3. Dependent Claims 2, 6, 7, 9–12, and 15*

Claims 2, 6, 7, and 9–12 and claim 15 depend from claims 1 and 14, respectively.

For the same reasons as set forth above, namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA "would have been motivated to replace the shade matching function of Babayoff with the shade matching function of Chu" (Pet. 26-27) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claims 2, 6, 7, 9–12, and 15 are unpatentable over Babayoff and Chu.

*F. Ground II—Obviousness over Babayoff, Chu, and Graham*

Petitioner challenges claim 3 as unpatentable under 35 U.S.C. § 103(a) over Babayoff, Chu, and Graham. Pet. 46.

Petitioner relies on its position under Ground I challenging the patentability of claim 1, from which claim 3 depends. Pet. 46 ("As

discussed *supra* in claim 1, Babayoff in combination with Chu uses measured color values compared with reference tooth shade vales to determine tooth shade values for dental prosthetics and restorations").

For the same reasons as set forth in section II.E.1., namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA "would have been motivated to replace the shade matching function of Babayoff with the shade matching function of Chu" (Pet. 26–27) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claim 3 is unpatentable over Babayoff, Chu, and Graham.

*G. Ground III—Obviousness over Babayoff, Chu, and Nathaniel*

Petitioner challenges claims 15–17 as unpatentable under 35 U.S.C. § 103(a) over Babayoff, Chu, and Nathaniel. Pet. 47.

Petitioner relies on its position under Ground I in challenging the patentability of claim 14, from which claims 15–17 depend. Pet. 47 ("The limitations of claim 14 are met by Babayoff and Chu for the reasons discussed supra in connection with Ground 1.").

For the same reasons as set forth in section II.E.1. and II.E.2, namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA "would have been motivated to replace the shade matching function of Babayoff with the shade matching function of Chu" (Pet. 26-27) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claims 15–17 are unpatentable over Babayoff, Chu, and Nathaniel.

*H. Ground IV—Obviousness over Babayoff and Inglese*

Petitioner challenges claims 1, 2, 7, and 9–15 as unpatentable under 35 U.S.C. § 103(a) over Babayoff and Inglese. Pet. 50.

According to Petitioner, "[t]o the extent the Board concludes that Chu does not disclose the shade matching and certainty scoring limitations discussed in connection with Ground 1 (e.g., 1[b], 1[c], 2, 7, 9, and 13), Inglese discloses these limitations and its combination with Babayoff was obvious for the reasons provided below." Pet. 50–51.

*1. Claim 1*

Petitioner contends that "Babayoff in combination with Inglese discloses" 1(b). Pet. 51 (citing Ex. 1003, ¶¶ 133–137).

Petitioner provides a basic explantion of what Babayoff discloses that is similar to that presented under Ground I, albeit abridged. *Cf*. Pet. 51 and *id*. at 20.

But Petitioner does not repeat its contention from Ground I that Babayoff does not teach determining a tooth shade *value* as claimed (*i.e.*, 1[b]). Be that as it may, Petitioner contends that "Inglese describes an intra-oral scanning device and method for determining tooth shade" (Pet. 51 (citing Ex. 1109 ¶ 1)) involving the use of, *inter alia*, "'known values of a first dental shade guide'" (*id*. at 53 (quoting Ex. 1109 ¶ 84)) and thereby implicitly acknowledges that Babayoff misses a teaching of determining a tooth shade value, for which Inglese is relied upon to fill.

Be that as it may, we are unpersuaded that Petitioner has provided sufficient articulated reasoning, with adequate rational underpinnings, explaining why an ordinary artisan would have modified Babayoff in light of

Inglese with a reasonable expectation of successfully arriving at the claimed subject matter.

Petitioner indicates that "[t]he teachings of Inglese are [] similar in all relevant respects to the teachings of Chu, discussed [] in connection with claim 1." Pet. 54 (citing Ex. 1003 ¶ 137). However, Inglese does not accomplish color matching in technically the same way as Chu. *See* section II.D.2. and 4.

Nevertheless, Petitioner explains that "Inglese describes a manner of measuring tooth shade where a sensor receives a measurement signal from the illuminated tooth and that signal is converted into Cartesian x, y, z coordinates in three dimensional shade space where reference points are also defined." Pet. 51–52 (citing Ex. 1109 ¶¶ 11–14). To illustrate, Petitioner provides an annotated version of Inglese Figure 5 with the "Measured Color Signal" 200 outlined in red, reproduced below. "[T]he dimensions of the shade space are symbolized by dotted line projections on the R, G, B dimension axes." Ex. 1109 ¶ 81 (quoted at Pet. 52).

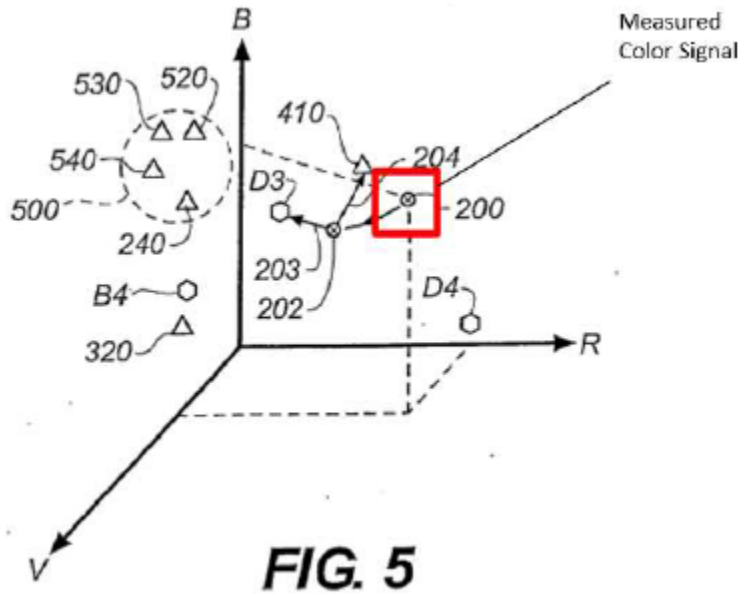


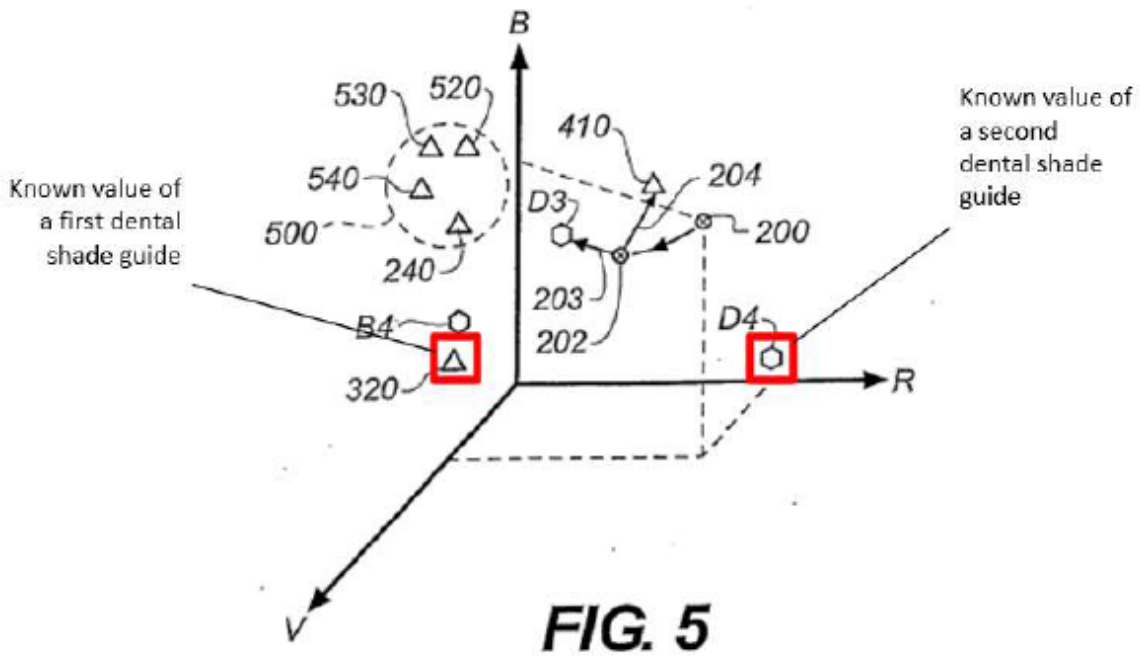

FIG. 5

> Petitioner's annotated version of Inglese Figure 5 that "illustrates the establishment of a tooth shade based on the measurement signal converted into a point of a shade space" (Ex. 1109, ¶ 76) with the "Measured Color Signal" 200 outlined in red.

Petitioner further explains that in Inglese "'[t]he reference point closest to the measurement point, possibly corrected, is sought to establish the shade of the relevant tooth part.'" Pet. 53 (quoting Ex. 1109 ¶ 85). Petitioner provides another annotated version of Inglese Figure 5 outlining in red reference points 320 (depicted as a triangle) and D4 (depicted as a small hexagon), reproduced below.

> [S]hown in the shade space are the reference points 320, 410, 540. These are shown as small triangles. *They correspond to known values of a first dental shade guide.* Another set of reference points B4, D3, D4, shown by small hexagons, c*orresponds to the shades of a second dental shade guide*.

Ex. 1109 ¶ 84 (quoted at Pet. 53) (emphasis added).




Petitioner's annotated version of Inglese Figure 5 outlining in red reference points 320 (depicted as a triangle) and D4 (depicted as a small hexagon) corresponding to shades of a first and second dental shade guides, respectively.

Petitioner contends that that the combination of Babayoff and Inglese would have led a POSA to the claimed method because:

> [a] POSA would have a reasonable expectation of success modifying Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth, and would know how to do so. Ex. 1003, ¶137. The modification would require nothing more than modifying Babayoff's algorithm to compare measured texture values with known texture values of reference tooth shade values, and select the closest match.

Pet. 54.

Patent Owner disagrees, arguing that the combination of Babayoff and Inglese would not have led a POSA to the claimed method because, *inter*

*alia*, the Babayoff and Inglese devices are "completely different." Prelim. Resp. 45. Patent Owner summarizes some of the differences:

> Babayoff discloses obtaining a 3D model having color. The Inglese device provides 2D color data alone. The Babayoff device obtains color data for points on the tooth. The Inglese device obtains color data for areas on the tooth. The Babayoff device places the color data in the same frame of reference as the X-Y array used for the 3D model. The Inglese device provides color for 2D image areas and there is no frame of reference for points in an X-Y array.

*Id*.

In our view, Patent Owner's characterization of the Babayoff and Inglese devices as being different devices with different objectives is supported by the Babayoff and Inglese disclosures and consistent with Petitioner's own overview of Babayoff and Inglese. *See* Pet. 7–9, 11–13. Babayoff seeks to provide a "numerical entity that is representative of the three-dimensional surface geometry and color of at least part of [an] intra-oral cavity." Ex. 1105, 7:54–56. This information is useful when producing a dental prothesis. *See* Pet. 8 ("An objective of Babayoff is to provide a color map for a dental prosthesis."). In Babayoff, shading concerns the prothesis and it is based on selecting certain teeth. Inglese describes a device for measuring dental shade, which device converts signals corresponding to a tooth part into coordinates defining reference points corresponding to preset shades of a dental shade guide. *See id*. at 11–13. The evidence supports the view that Babayoff and Inglese devices are different and have different objectives.

Yet Petitioner does not address the differences between the Babayoff and Inglese devices and their objectives.

Petitioner asserts that "[i]t would have been obvious to a POSA [] to replace the manual or algorithmic process of shading a restoration using texture data from surrounding teeth [as taught in Babayoff], with the automated process of shading a restoration using texture data from reference tooth shade values of a shade guide as taught by Inglese." Pet. 54 (citing Ex. 1003 ¶ 136). Petitioner cites Dr. Kakadiaris's testimony in support of its assertion. *Id*. But Dr. Kakadiaris simply repeats, without factual support, Petitioner's assertion. *Cf*. Pet. 54 and Ex. 1003 ¶ 136.

Dr. Kakadiaris's testimony does not provide any insight into why a POSA would have replaced Babayoff's process of basing the shading of a prothesis on surrounding teeth with Inglese's process of measuring dental shade whereby signals corresponding to a tooth part are converted into coordinates defining reference points corresponding to preset shades of a dental shade guide.

Petitioner asserts that a POSA "would *know* to" "modify[] Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth." Pet. 54 (citing Ex. ¶ 137) (emphasis added). "The modification would require nothing more than modifying Babayoff's algorithm to compare measured texture values with known texture values of reference tooth shade values, and select the closest match." *Id*.

Petitioner cites Dr. Kakadiaris's testimony in support of its assertion. Pet. 54 (citing Ex. ¶ 137). But Dr. Kakadiaris does not indicate that a POSA "would *know* to" modify Babayoff as asserted and simply repeats, without factual support, Petitioner's assertion that "[t]he modification would require nothing more than modifying Babayoff's algorithm to compare measured

texture values with known texture values of reference tooth shade values, and select the closest match." *Cf*. Pet. 54 and Ex. 1003 ¶ 137.

Dr. Kakadiaris's testimony provides no insight into why it is that a POSA would have *known* to "modify[] Babayoff's algorithm to compare measured texture values with known texture values of reference tooth shade values" (Pet. 54) as in Inglese given that, as Patent Owner correctly points out, "[t]here is no mention of the use of a shade guide [as in Inglese] to determine the shade of the prosthesis [in Babayoff] because [in Babayoff] the shade of the prosthesis is determined based on the selected teeth and not a shade guide" (Prelim. Resp. 44).

By not addressing the differences between the Babayoff and Inglese devices and their objectives, Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA would have been motivated to "modify[] Babayoff to compare tooth shade with tooth shade guide values [as in Inglese], rather than tooth shade values from the patient's teeth" (Pet. 54) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b].

For the above reasons, we are unpersuaded that the Petition establishes a reasonable likelihood that claim 1 is unpatentable over the combination of Babayoff and Inglese.

*2. Claims 13 and 14*

Petitioner's contention that "Babayoff in combination with Inglese discloses" 1(b) (Pet. 51 (citing Ex. 1003, ¶¶ 133–137) also applies to claims 13 and 14. See *id*. at 64, 66.

For the same reasons, therefore, as set forth above for the corresponding limitation of independent claim 1, the Petition does not

establish a reasonable likelihood that claims 13 and 14 are unpatentable over Babayoff and Inglese.

*3. Dependent Claims 2, 7, 9–12, and 15*

For the same reasons as set forth above, namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA would have been motivated to "modify[] Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth" (Pet. 54) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claims 2, 7, 9–12, and 15 are unpatentable over Babayoff and Inglese.

*I. Ground V—Obviousness over Babayoff, Inglese, and Graham*

Petitioner challenges claim 3 as unpatentable under 35 U.S.C. § 103(a) over Babayoff, Inglese, and Graham. Pet. 67.

Petitioner relies on its position under Ground IV challenging the patentability of claim 1, from which claim 3 depends. Pet. 67 ("It would have been obvious to combine Babayoff and Inglese for the reasons described in connection with claim 1 . . . .").

For the same reasons as set forth in section II.H.1., namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA would have been motivated to "modify[] Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth" (Pet. 54) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claim 3 is unpatentable over Babayoff, Inglese, and Graham.

### *J. Ground VI—Obviousness over Babayoff, Inglese, and Nathaniel*

Petitioner challenges claims 15–17 as unpatentable under 35 U.S.C. § 103(a) over Babayoff, Inglese, and Nathaniel. Pet. 69.

Petitioner relies on its position under Ground I in challenging the patentability of claim 14, from which claims 15–17 depend. Pet. 69 ("The limitations of claim 14 are met by Babayoff and Inglese for the reasons discussed *supra* in connection with Ground 4.").

For the same reasons as set forth in section II.H.1. and II.H.2, namely, that Petitioner provides insufficient reasoning with rational underpinnings in support of its contention that a POSA would have been motivated to "modify[] Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth" (Pet. 54) with a reasonable expectation of successfully arriving at the claimed invention comprising 1[b], the Petition does not establish a reasonable likelihood that claims 15–17 are unpatentable over Babayoff, Inglese, and Nathaniel.

## III. CONCLUSION

For the foregoing reasons, we determine that Petitioner has not demonstrated a reasonable likelihood that it would prevail in showing the unpatentability of at least one of claims 1–3, 6, 7, and 9–17 of the '151 patent. Accordingly, we deny the Petition.

## IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), *inter partes* review of claims 1–3, 6, 7, and 9–17 of the '151 patent is denied.

FOR PETITIONER:

John McKee
James Glass
QUINN EMANUEL URQUHART & SULLIVAN, LLP
johnmckee@quinnemanuel.com
jimglass@quinnemanuel.com

Jeanne Gills
FOLEY & LARDNER LLP
jmgills@foley.com

FOR PATENT OWNER:

Todd Walters
Roger Lee
Mythili Markowski
Andrew Cheslock
BUCHANAN INGERSOLL & ROONEY PC
todd.walters@bipc.com
roger.lee@bipc.com
mythili.markowski@bipc.com
andrew.cheslock@bipc.com