

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3SHAPE A/S and 3SHAPE INC.,
Petitioner,

v.

ALIGN TECHNOLOGY, INC.,
Patent Owner.

IPR2019-00153
Patent 6,334,853 B1

Before BRIAN J. MCNAMARA, NEIL T. POWELL, and
ELIZABETH M. ROESEL, *Administrative Patent Judges*.

ROESEL, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

3Shape A/S and 3Shape Inc. (“Petitioner”) filed a Petition (Paper 3, “Pet.”) requesting *inter partes* review of claims 1–3, 5, 7, and 9–13 (“the challenged claims”) of U.S. Patent No. 6,334,853 B1 (Ex. 1001, “the ’853 Patent”). Align Technology, Inc. (“Patent Owner”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”). On June 3, 2019, we instituted an *inter partes* review as to all claims challenged in the Petition. Paper 8 (“Dec.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 12, “PO Resp.”), Petitioner filed a Reply (Paper 17, “Reply”), and Patent Owner filed a Sur-reply (Paper 20, “Sur-reply”). An oral hearing was held on March 11, 2020, and a transcript of the hearing is included in the record (Paper 27, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7, and 9–13 of the ’853 Patent are unpatentable.

I. BACKGROUND

A. *Real Parties in Interest*

Petitioner identifies the real parties in interest as 3Shape A/S, 3Shape Inc., 3Shape Holding A/S, 3Shape Trios A/S, and 3Shape Poland sp. z.o.o. Pet. 1. Petitioner lists additional real parties in interest “[o]ut of an abundance of caution . . . for purposes of compliance with 35 U.S.C. § 312(a)(2).” *Id.* at 1–2, App. B. Patent Owner identifies the real party in interest as Align Technology, Inc. Paper 5, 1 (Mandatory Notices).

B. Related Matters

The parties identify the following civil action and investigation as related matters: *Align Technology, Inc. v. 3Shape A/S*, No. 1:17-cv-01648 (D. Del., filed Nov. 14, 2017), and *In the Matter of Certain Intraoral Scanners and Related Hardware and Software*, Inv. No. 337-TA-1090 (U.S. Int'l Trade Comm'n, complaint filed Nov. 14, 2017). Pet. 2; Paper 5, 1.

C. The '853 Patent (Ex. 1001)

The '853 Patent discloses a method for obtaining a dental occlusion map of a three-dimensional virtual computer model of teeth of upper and lower jaws of a mouth. Ex. 1001, code (57). The occlusion map graphically represents the distances between opposite points or regions on facing surfaces of opposite teeth of the upper and lower jaws of the mouth. *Id.* at code (57), 1:57–60, 1:63–65. The method uses a three-dimensional virtual dental model obtained directly by scanning and digitizing the teeth and gums or indirectly by utilizing a plaster dental model or negative impression. *Id.* at 1:45–48, 1:60–62.

Figures 1 and 2 of the '853 Patent are reproduced below:

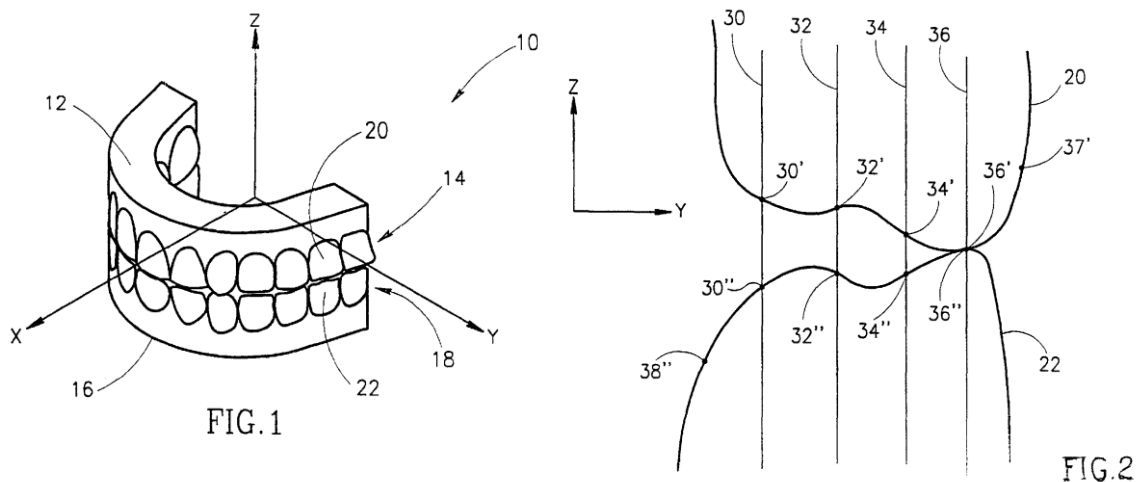


Figure 1 (on the left) shows a virtual image dental model in the occluded state, including a pair of opposite teeth 20 and 22, and Figure 2 (on the right)

shows a cross-sectional view through upper tooth 20 and opposite lower tooth 22. Ex. 1001, 2:53–57, 3:31–37, 3:41. In Figure 1, a rectangular Cartesian coordinate system XYZ is superimposed on the dental model, with the XY-plane coinciding with the occlusion plane¹ and the ZY-plane substantially perpendicular to the buccal and lingual sides of teeth 20 and 22 at the rear of the jaw. *Id.* at 3:18–22, 3:40–44. The cross-section in Figure 2 is taken in the ZY-plane at an arbitrary value of X. *Id.* at 2:55–57, 3:39–40. As shown in Figure 2, grid lines 30, 32, 34, and 36 are parallel to the Z-axis and intersect the surface of upper tooth 20 at points 30', 32', 34', and 36' and intersect the surface of lower tooth 22 at points 30'', 32'', 34'', and 36'', respectively, resulting in pairs of opposite points (30', 30''), (32', 32''), (34', 34''), and (36', 36''). *Id.* at 3:47–60. According to the '853 Patent, each pair of points “has the same (X, Y) coordinates but a different Z coordinate, depending on the relative separation of the opposite points of each pair.” *Id.* at 3:57–60.

The '853 Patent discloses that the distance between opposite points on a grid line is determined by taking the absolute value of the difference between the Z coordinates. Ex. 1001, 4:24–42. Each value of distance is then related to a corresponding shade on a grey scale or a corresponding color on a color scale and mapped onto a pixel, with the distance between adjacent pixels equal to the distance between adjacent grid lines. *Id.* at 4:42–5:3, Fig. 3. This process is repeated for additional cross-sections, resulting in an occlusion map as shown in Figure 4. *Id.* at 5:4–25, 5:49–51.

¹ According to the '853 Patent, “[t]he occlusion plane is defined as the horizontal plane through the tips of the buccal cusps of the premolars or the tips of the mesiobuccal cusps of the first molars and first premolars.” Ex. 1001, 3:22–25.

Figures 4 and 5 of the '853 Patent are reproduced below:

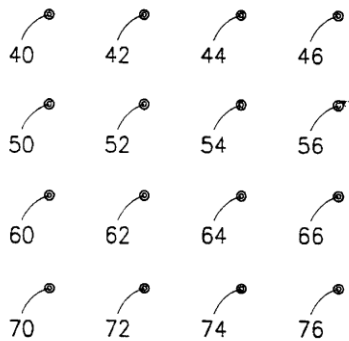


FIG. 4

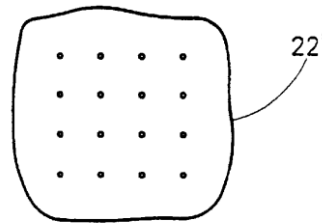


FIG. 5

Figure 4 shows a map onto a plane of the distances between four pairs of opposite points in four different parallel cross-sectional planes taken parallel to the ZY-plane at different values of X. Ex. 1001, 2:60–63. Figure 5 shows a map of the distances of Figure 4 (on a smaller scale) superimposed on outline 22' of the plan view of lower tooth 22 looking in the negative Z direction. *Id.* at 2:64–67, 5:51–56. An occlusion map according to the '853 Patent may show multiple teeth of the lower jaw or multiple teeth of the upper jaw. *Id.* at 5:61–67, Fig. 6.

Another embodiment is shown in Figure 8 of the '853 Patent, which is reproduced below:

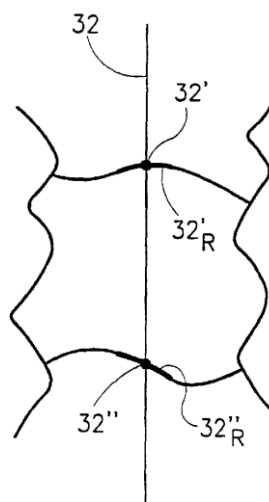


FIG. 8

Figure 8 shows a partial cross-sectional view through upper tooth 20 and opposite lower tooth 22 around points 32' and 32" of Figure 2, with point 32' surrounded by region 32'_R and point 32" surrounded by region 32"_R.

Ex. 1001, 3:9–12, 6:54–60. According to the '853 Patent, the distance between points 32' and 32" is taken to represent the distance between regions 32'_R and 32"_R, and these distances can be mapped onto one or more pixels.

Id. at 7:5–11.

D. Illustrative Claim

The '853 Patent includes thirteen claims. Claims 1–3, 5, 7, and 9–13 are challenged in the Petition. Claim 1 is the only independent claim and is reproduced below:

1. A method for obtaining a dental occlusion map of a three-dimensional virtual computer model of teeth of upper and lower jaws of a mouth, said occlusion map indicative of distances between opposite regions on facing surfaces of opposite teeth of the upper and lower jaws of the mouth, said method comprising the steps of:

(i) determining said distances between opposite regions on opposite teeth of the upper and lower jaws of the mouth; and

(ii) setting up a correspondence between said determined distances and regions on a mapping surface.

Ex. 1001, 7:53–8:7.

E. Prior Art and Asserted Grounds

Petitioner asserts the following grounds of unpatentability:

	Claims Challenged	35 U.S.C. §	References
1	1–3, 5, 7, and 9–11	102(b) ²	Kunii ³
2	1–3, 5, 7, and 9–11	103(a)	Kunii
3	3, 5, 7, 12, and 13	103(a)	Kunii and Hayashi ⁴
4	1–3, 5, and 9–11	102(b)	Myszkowski ⁵
5	12 and 13	103(a)	Myszkowski and Hayashi

We refer to Petitioner’s grounds 1–3 as the “Kunii-based grounds” and grounds 4 and 5 as the “Myszkowski-based grounds.”

F. Additional Evidence

In addition to the prior art cited above, Petitioner relies on a Declaration of Parris Egbert, Ph.D. Ex. 1006. Patent Owner cross-examined Dr. Egbert and filed a transcript of his deposition as Exhibit 2006.

Patent Owner relies on a Declaration of Dr. Chandrajit L. Bajaj (Ex. 2004) and a Declaration of Dr. Maureen A. Valley (Ex. 2003).

² The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 102, 103, effective March 16, 2013. Because the application from which the ’853 Patent issued was filed before this date, the pre-AIA version of §§ 102, 103 applies.

³ Ex. 1003, Tosiyasu Kunii et al., *Evaluation of Human Jaw Articulation*, Computer Animation ’95 Proceedings (Demetri Terzopoulos and Daniel Thalmann, eds., IEEE Computer Society Press 1995), 163–171 (“Kunii”).

⁴ Ex. 1005, Toyohiko Hayashi et al., *Three-Dimensional Analysis of Tooth Occlusion Using Distance Map*, Biomechanisms, vol. 12, pp. 27–37 (Society of Biomechanisms Japan, ed. Tokyo University Press 1994) (“Hayashi”). Exhibit 1005 includes a Japanese language original, an English language translation, and a certificate of translation.

⁵ Ex. 1004, Karol Myszkowski et al., *Visualization And Analysis Of Occlusion For Human Jaws Using A “Functionally Generated Path,”* Proceedings Of SPIE, Visual Data Exploration and Analysis III (8 March 1996), vol. 2656, pp. 360–367 (“Myszkowski”).

Petitioner cross-examined Patent Owner's declarants and filed transcripts of their depositions as Exhibit 1019 (Dr. Bajaj) and Exhibit 1018 (Dr. Valley).

II. ANALYSIS

A. *Legal Standards*

“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”)); *see also* 37 C.F.R. § 42.104(b) (requiring a petition for *inter partes* review to identify how the challenged claim is to be construed and where each element of the claim is found in the prior art patents or printed publications relied upon).

A claim is anticipated under 35 U.S.C. § 102 only if “each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co.*, 814 F.2d 628, 631 (Fed. Cir. 1987). A claim is unpatentable under 35 U.S.C. § 103 if “the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the 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 skill in the art; and,

when in evidence, (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Additionally, the obviousness inquiry typically requires an analysis of “whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR*, 550 U.S. at 418 (*citing In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2016) (requiring “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness”)). Furthermore, Petitioner does not satisfy its burden of proving obviousness by employing “mere conclusory statements,” but “must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

B. Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art (“POSITA”) would have at least (1) a bachelor’s degree in computer science and/or computer engineering (or equivalent course work) and two to three years of work experience in computer modelling of physical structures or (2) a master’s degree in computer engineering and/or computer science (or equivalent course work) with a focus in computer modelling of physical structures. Pet. 28 (citing Ex. 1006 ¶ 24).

Patent Owner criticizes Petitioner’s assertion as lacking any requirement for knowledge of dentistry and failing to consider the POSITA’s knowledge and experience of dental and/or orthodontic applications of computer modeling. PO Resp. 13–14. Patent Owner argues that “a POSITA would have knowledge, education, and experience in computer modeling, specifically of teeth and jaws, in addition to knowledge,

education, and experience in dentistry, orthodontics, prosthodontics, and/or oral surgery.” *Id.* at 15, 16 (citing Ex. 1001, 1:10–20, 6:4–5; Ex. 2003 ¶¶ 22–26; Ex. 2004 ¶¶ 25–31). Patent Owner relies on the Hayashi reference, which Patent Owner asserts “was written by a team of imaging experts and dental experts.” *Id.* at 15.

Neither party asserts that the definition of a POSITA is a dispositive issue. Petitioner argues that the challenged claims are unpatentable under both parties’ definitions of a POSITA. Reply 24, 26. Patent Owner argues that its “arguments and the opinions of its expert do not change regardless of whether the Board adopts Petitioner’s or Patent Owner’s proposed level of skill in the art.” Sur-Reply 9.

We agree with Patent Owner that a POSITA would have knowledge and experience with the dental and/or orthodontic applications of computer modeling. Our finding is supported by the language of claim 1, which recites a “method for obtaining a dental occlusion map of a three-dimensional virtual computer model of teeth of upper and lower jaws of a mouth.” Ex. 1001, 7:53–8:7. Accordingly, we determine that a POSITA would have at least (1) a bachelor’s degree in computer science and/or computer engineering (or equivalent course work) and two to three years of work experience in computer modelling of physical structures, including some knowledge or experience with computer modelling of jaws and teeth for dental and/or orthodontic applications, or (2) a master’s degree in computer engineering and/or computer science (or equivalent course work) with a focus in computer modelling of physical structures, including some knowledge or experience with computer modelling of jaws and teeth for dental and/or orthodontic applications.

Patent Owner argues that that Petitioner’s declarant, Dr. Egbert, “is not qualified to opine on matters relating to the ’853 Patent, given his lack of knowledge in the relevant arts including dentistry, orthodontics, prosthodontics, and/or oral surgery.” PO Resp. 16. Petitioner argues that Patent Owner’s declarant, Dr. Bajaj, also has no formal training or experience in dentistry and that obtaining a working knowledge of dentistry from prior art literature, as Dr. Egbert did, is no different from obtaining a working understanding of dentistry from Dr. Valley’s written report, as Dr. Bajaj did. Reply 25–26.

Of the parties’ declarants, only Dr. Egbert and Dr. Bajaj have provided opinions regarding claim construction and whether the subject matter of the challenged claims would have been obvious to a POSITA. Dr. Valley did not do so. Ex. 2003; Ex.1018, 6:18–22. Dr. Bajaj states that he reviewed Dr. Valley’s report, but does not rely on it to support any of his opinions. Ex. 2004 ¶ 22. Neither Dr. Egbert nor Dr. Bajaj has formal training or experience in dentistry. Ex. 2006, 16:17–17:5; Sur-Reply 10 (“Dr. Bajaj does not have formal training in dentistry”). Nevertheless, we agree with Petitioner that both witnesses have expertise that is relevant to 3D modeling and imaging of teeth and jaws. Reply 25; Ex. 1006 ¶¶ 6–11; Ex. 1007; Ex. 2004 ¶¶ 8–21; Ex. 2006, 17:6–13; Ex. 2014. We find that Dr. Egbert and Dr. Bajaj each has sufficient education and experience to be “qualified in the pertinent art” and to offer testimony in the form of an opinion. *Sundance, Inc. v. DeMonte Fabricating Ltd.*, 550 F.3d 1356, 1363–64 (Fed. Cir. 2008); Fed. R. Evid. 702; Consolidated Trial Practice Guide 34 (November 2019), <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

C. *Claim Construction*

Although the Petition was filed before the effective date of a recent rule change, we nevertheless apply the same claim construction standard as applies in district court because, as the parties agree, the '853 Patent has expired.⁶ Pet. 28; PO Resp. 5 (“[T]he *Phillips* standard is the applicable standard here . . .”). See *In re Rambus, Inc.*, 694 F.3d 42, 46 (Fed. Cir. 2012). Accordingly, we construe the claims to have their ordinary and customary meaning, as that meaning would be understood by one of ordinary skill in the art in the context of the entire patent disclosure. See *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc); *Thorner v. Sony Comput. Entm’t Am. LLC*, 669 F.3d 1362, 1365–66 (Fed. Cir. 2012) (unless a claim term has been expressly defined by the patentee or has been limited by a clear and unmistakable disavowal of claim scope, then it should receive its ordinary meaning).

We address the disputed claim terms below. We determine that no other claim term requires express construction for purposes of resolving the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“only those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy”); see also *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (applying *Vivid Techs.* in the context of *inter partes* review).

⁶ A recent amendment to 37 C.F.R. § 42.100(b) does not apply here. See Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (now codified at 37 C.F.R. pt. 42 (2019)).

1. “*opposite regions*”

The term “opposite regions” appears twice in claim 1. The preamble recites: “said occlusion map indicative of distances between opposite regions on facing surfaces of opposite teeth of the upper and lower jaws of the mouth.” Ex. 1001, 7:56–8:1. The body of claim 1 recites: “determining said distances between opposite regions on opposite teeth of the upper and lower jaws of the mouth.” *Id.* at 8:3–5.

Patent Owner contends that “opposite regions” should be construed as “[p]oints and/or the circular, elliptic, or irregular shape surrounding points [on (facing surfaces of) opposite teeth] that intersect the same z-axis line.” PO Resp. 9. Patent Owner’s construction would require that “distances between opposite regions” be determined along the z-axis gridline. *See id.* at 7–9.

Petitioner argues that Patent Owner’s construction is not supported by the claim language, the Specification, or the file history of the ’853 Patent. Reply 1–4. Petitioner contends that “[t]he ’853 specification discloses determining distance between points in a direction ***other than*** along the same z-axis line.” *Id.* at 2 (citing Ex. 1001, 5:26–35).

As support for its construction, Patent Owner relies on Figures 1, 2, 6, and 8 and the corresponding descriptions in the ’853 Patent. *See* PO Resp. 7–9. Figure 1, for example, shows a Cartesian coordinate system superimposed on a dental model, and Figure 2 shows determining distances along “grid lines [that] are parallel to the Z-axis.” Ex. 1001, 3:18–22, 48–50; *see also id.* at 5:32–33 (“The grid lines are all parallel to each other and are preferably perpendicular to the occlusion plane.”).

The ’853 Patent makes clear that the drawings and descriptions relied upon by Patent Owner are “by way of example only.” Ex. 1001, 2:49–51.

The '853 Patent counsels against reading limitations from the Specification into the claims, stating: “although the present invention has been described to a certain degree of particularity, but it should be understood that various alterations and modifications can be made without departing from the spirit or scope of the invention as hereinafter claimed.” *Id.* at 7:47–51. Although Patent Owner’s construction is consistent with the examples disclosed in the Specification, the claim language is broader. The claims make no reference to Cartesian coordinates, parallel gridlines, or determining distance along a z-axis line.

Unless “the patentee has chosen to be his own lexicographer in the specification or has clearly disclaimed coverage during prosecution,” we must interpret claims according to their plain language. *E-Pass Techs., Inc. v. 3Com Corp.*, 343 F.3d 1364, 1370 (Fed. Cir. 2003). Although determining distance along z-axis gridlines is the '853 Patent’s sole example of how to make distance determinations, “[i]t is not enough for a patentee to simply disclose a single embodiment or use a word in the same manner in all embodiments, the patentee must ‘clearly express an intent’ to redefine the term.” *Bradium Techs. LLC v. Iancu*, 923 F.3d 1032, 1044 (Fed. Cir. 2019) (quoting *Thorner*, 669 F.3d at 1365).

On the other hand, we disagree with Petitioner’s argument that “[t]he '853 specification discloses determining distance between points in a direction **other than** along the same z-axis line.” Reply 2 (citing Ex. 1001, 5:26–35). At best, the '853 Patent discloses the distance between points intersecting the same z-axis line as a **non-limiting example** of how to make distance determinations. No other specific example is given.

In the context of addressing the Myszkowski-based grounds in the Institution Decision, we stated:

Despite the requirement for particularity in a petition for IPR and the requirement that a petition identify how a challenged claim is to be construed, Petitioner does not propose an express construction for “distances between opposite regions.” Moreover, Petitioner presents no argument or evidence that this phrase should be construed more broadly than is illustrated in Figure 2 of the ’853 patent, which Petitioner asserts shows measuring distance along a fixed projection direction.

Dec. 28–29 (citing Pet. 51). At this juncture, after completion of trial, Petitioner still has not proposed an express construction for “distances between opposite regions.” As discussed above, however, Petitioner has presented argument and evidence that Patent Owner’s proposed construction is narrower than is warranted by the intrinsic evidence. Reply 1–4.

For the reasons discussed below, we determine that Petitioner has established unpatentability of all challenged claims based on the Kunii-based grounds, even under Patent Owner’s construction for “opposite regions.” Accordingly, for purposes of resolving the controversy, we do not need to determine whether Patent Owner’s construction is too narrow, as argued by Petitioner.

2. “*occlusion map*”

Petitioner contends that “occlusion map” should be construed as a “graphical representation of the distance between opposite points, or regions, on the surface of opposite teeth’ and encompasses a two-dimensional graphical representation.” Pet. 29 (quoting Ex.1001, 1:63–65 and citing *id.* at 2:19–22). Patent Owner argues that Petitioner’s construction should be rejected, but does not propose a construction of its own. PO Resp. 10–13. We find that Petitioner’s construction is supported by the intrinsic evidence and that Patent Owner’s counterarguments are not persuasive.

Petitioner’s construction incorporates an express definition from the Specification. The ’853 Patent states: “The resulting graphical representation of the distance between opposite points, or regions, on the surface of opposite teeth will be termed an ‘occlusion map.’” Ex. 1001, 1:63–65. This statement includes linguistic indicia of a definition, including quotation marks around the claim term preceded by the word “termed.” Except for word order, the sentence is linguistically consistent with other definitional language in the Specification. *Id.* at 2:4–7 (definition of “color”). Patent Owner does not dispute that this sentence is definitional. Instead, Patent Owner argues that Petitioner “misleadingly” relies on the Specification’s definition to broaden the term “occlusion map” “such that it reads on various incompatible embodiments.” PO Resp. 12. That argument is not a persuasive reason to reject Petitioner’s proposal to construe “occlusion map” in accordance with the express definition in the Specification.

Petitioner’s construction further provides that an “occlusion map” “encompasses a two-dimensional graphical representation.” Pet. 29. This provision is supported by the Specification’s disclosure that the occlusion map can be “a two-dimensional map of the distances between said opposite regions on said opposite teeth.” Ex. 1001, 2:19–22. Patent Owner does not dispute that an “occlusion map” can be two-dimensional. PO Resp. 11. Patent Owner’s counterargument relates to patentability rather than claim construction.

Patent Owner contends that Petitioner’s definition of “occlusion map” renders superfluous the claim phrase “the distances between said opposite regions on said opposite teeth.” PO Resp. 11. We disagree. The ’853 Patent expressly defines an “occlusion map” in a manner that incorporates

language similar to that recited elsewhere in the claim. Adopting a patent's express definition for a claim term does not render another similarly-worded claim phrase superfluous. None of the cases cited by Patent Owner holds otherwise. PO Resp. 11–12.⁷

Accordingly, we adopt Petitioner's construction for "occlusion map" as a "graphical representation of the distance between opposite points, or regions, on the surface of opposite teeth and encompasses a two-dimensional graphical representation." Pet. 29.

3. "*color*"

Petitioner contends that the term "color" should be construed as "encompassing all colors and shades of colors and black and white and all shades of grey between black and white on a grey scale." Pet. 29 (citing Ex. 1001, 2:4–7). Patent Owner does not object to Petitioner's proposed construction for "color." PO Resp. 13. Petitioner's construction is supported by an express definition in the Specification, and for that reason, we adopt it. Ex. 1001, 2:4–7 ("The term 'color' used herein includes not

⁷ Patent Owner's cases did not involve an express definition that mimicked other claim language. *See, e.g., Wasica Fin. GmbH v. Cont'l Auto. Sys., Inc.*, 853 F.3d 1272, 1288 (Fed. Cir. 2017) ("Construing 'bit sequence' to allow for an empty, zero-bit sequence would effectively remove the 'first bit sequence,' 'second, or third bit sequence,' and 'fourth and final bit sequence' limitations from the claim, as it would make them optional or potentially nonexistent."); *Bicon, Inc. v. Straumann Co.*, 441 F.3d 945, 951 (Fed. Cir. 2006) ("If we were to accept [patentee's] arguments, we would be requiring the public to look past the plain language of the claims and guess whether a detailed description of a structural feature in a claim is superfluous to the scope of the claimed invention and unnecessary to establish infringement.").

only all colors and shades of colors but also black and white and all shades of grey between black and white on a grey scale.”).

D. Overview of Prior Art References

Below we provide an overview of the Kunii and Hayashi references relied upon by Petitioner.

1. Kunii (Ex. 1003)

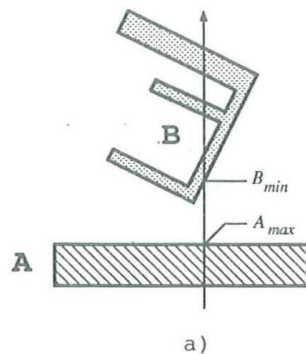
Kunii relates to computer-aided diagnosis and treatment of occlusal disorders and design of dental restorations. Ex. 1003, 163-1 (Abstract, Introduction).⁸ Kunii discloses distance maps as an approach for evaluating jaw occlusion. *Id.* (Abstract). According to Kunii, “[o]ur basic idea for evaluation of occlusion is to estimate interaction between teeth using *distance maps*.” *Id.* at 163-2. Kunii’s distance maps were created using “real data” including “scanned surfaces of the upper and lower jaw.” *Id.*

Kunii describes how to calculate a distance map. Ex. 1003, 164–165 (§ 2, “Calculation of distance maps”). According to Kunii, “[t]he characteristics of contact between the surfaces of the upper and lower jaw (or in a more general context, any complex objects) may be found from distances between points on surfaces of these objects.” *Id.* at 164-1. Kunii discloses two ways to measure this distance: either “along a fixed projection direction,” or by considering “multiple directions” and deriving “the minimal or average distances.” *Id.* According to Kunii, the first way is “the simplest,” but is “strongly affected by the choice” of direction. *Id.* The second way, says Kunii, is “more reliable,” but is “computationally more

⁸ Where appropriate, we cite to Exhibits 1003 and 1005 using a page number followed by a hyphenated suffix “-1” or “-2” to refer to the left-hand or right-hand column, respectively, on the cited page.

expensive.” *Id.*; see also *id.* at 166-1 (“[U]se of multiple projections allows detection of more active regions and yields a more accurate distance map.”). Kunii refers to the first method as “the single projection technique” and the second method as “the multiprojection technique.” *Id.* at 165-2. According to Kunii, only the multiprojection technique requires the determination of an average or minimum distance. *Id.* at 164-1, 165-1, 165-2.

Kunii illustrates a distance measurement along a fixed projection direction in Figure 1a, which is reproduced below:



Ex. 1003, 164. Kunii Figure 1a illustrates the calculation of the distance $d = B_{min} - A_{max}$ between objects A and B along a projection direction, which is indicated by an upwardly pointing arrow. *Id.* (Figure 1 caption). The data needed for this calculation is obtained by scanning the objects A and B and converting the scanned image using rasterizing graphics hardware. *Id.* at 164-2. Kunii discloses that “[t]he measurement of depth is done independently for each object at discrete sample points (pixels).” *Id.* Kunii further discloses that “the distance between the objects is calculated as the difference d between the minimal depth B_{min} recorded when the first object is scan-converted, and the corresponding maximal depth A_{max} for the second object.” *Id.* According to Kunii, this calculation can be used to determine

distances between points on the surfaces of the upper and lower jaw. *Id.* at 164-1. In such a case, models of jaws are derived from scanning casts of teeth, an example of which is shown in Kunii Figure 2 reproduced below:

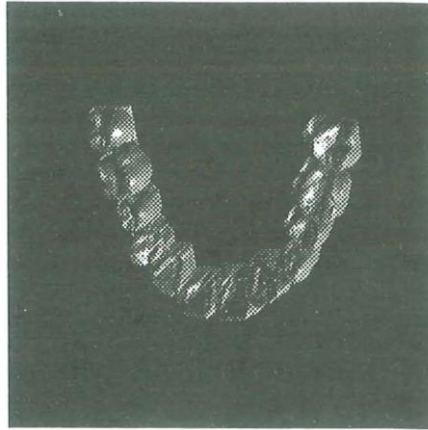


Figure 2: Occlusal surface of a jaw.

Ex. 1003, 164-1. Kunii Figure 2 shows the occlusal surface of a jaw obtained by scanning a cast of teeth. *Id.* at 164-1 (Figure 2 caption), 164-2.

Kunii discloses two ways of graphically displaying the results of distance measurements: distance images and distance maps. Examples are shown in Figure 3, which is reproduced below:

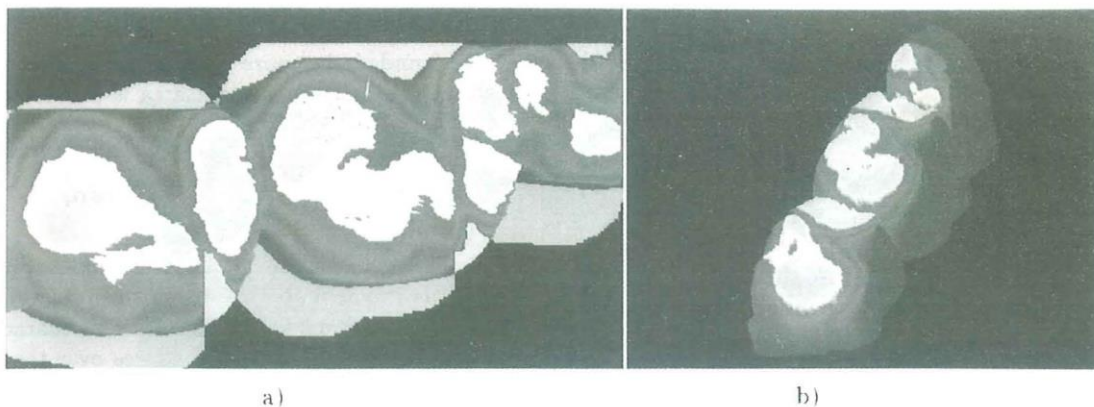


Figure 3: Graphical display of a distance image (a) and a distance map (b).

Ex. 1003, 165. Kunii Figure 3a shows a graphical display of a distance image, and Kunii Figure 3b shows a graphical display of a distance map. *Id.* (Figure 3 caption). Kunii describes Figure 3a as follows:

Fig. 3a shows an example of a distance image: pink and white regions correspond to areas in lower and upper jaws, respectively, that have no corresponding point in the opposite jaw in the direction of the current projection; regions marked by blue and green are those where the distance in the projection direction between the jaws exceeds 1 mm, and borders between green and yellow correspond to distances below 1 mm; colors between yellow and red correspond to distances below 1 mm; zero distance, i.e., contact between the surfaces, would be pure red.

Ex. 1003, 165-1.⁹ According to the foregoing description, the distances in Figure 3a were determined in a single, fixed direction—“the direction of the current projection.” *Id.* Kunii discloses that, “when multiple projections are used,” calculating a distance image is difficult. *Id.* For this situation, Kunii proposes “project[ing] the distance image back into the object space.” *Id.* The back-projection results in a distance map as shown in Figure 3b, which Kunii describes as follows:

[W]e call the *distance map* the function on the surface of one of the objects (or a graphical representation of this function) whose value at a point of the surface is equal to the distance from the other surface. The distance maps are view-independent and can be inspected by a dentist interactively. A color fringe (pseudo-color) technique is used to encode the distance for graphical display (Fig. 3b: the meaning of colors is the same as in Fig. 3a).

Ex. 1003, 165-2.

⁹ Although Exhibit 1003 is black and white, Exhibit 1011 is a color copy of Kunii. The Petition reproduces color versions of Kunii Figures 3 and 4 from Exhibit 1011. *See, e.g.*, Pet. 15, 16, 20.

Kunii provides an additional example of a distance map in Figure 4, which is reproduced below:

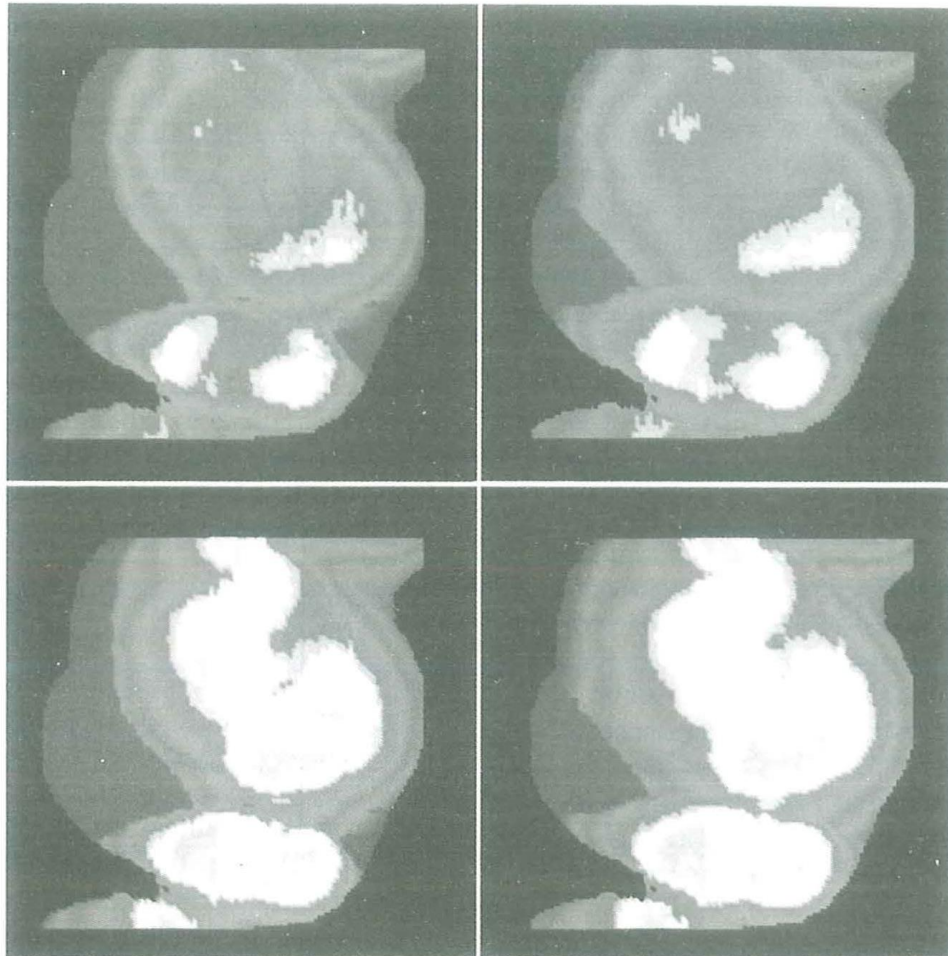


Figure 4: Distance map in the surface of a molar tooth.

Ex. 1003, 167. Kunii Figure 4 shows a distance map in the surface of a molar tooth. *Id.* (Figure 4 caption). Kunii provides the following description of Figure 4:

Fig. 4 shows distance maps found for the upper left first molar for two positions of the lower jaw. Unlike Fig. 3, we do not use color interpolation in the contact area here; borders between different tones of yellow and orange correspond to 0.2 mm intervals in distance. Images on the left were obtained using

single projection technique, and the ones on the right were produced using 13 projection directions.

Id. at 166-1.

2. *Hayashi (Ex. 1005)*

Hayashi predates Kunii. Hayashi relates to three-dimensional analysis of tooth occlusion using a distance map. Ex. 1005, 27 (Title). Hayashi explains that “tooth occlusion” refers to “the pairing relationship of the upper and lower jaw dentition” not only where the jaws are in “maximum engagement,” but also where “there is even the slightest amount of contact” between the jaws. *Id.* at 27-1 (Introduction). Hayashi acknowledges research into the use of CAD/CAM¹⁰ to design and manufacture dental prostheses and the accompanying development of methods, such as laser scanning, for obtaining digital data representing the three-dimensional shape of teeth. *Id.* Such digital data, according to Hayashi, makes it possible “to perform occlusion analysis using a computer” and “to quantitatively evaluate not only the contact sites, but also the pairing relationship of the entire tooth engagement surface (occlusion surface).” *Id.*

Hayashi proposes using a distance map to represent quantitatively the degree of proximity, i.e., distance, between paired occlusion surfaces. Ex. 1005, 27-2, 29-2 (§ 3.2, “Quantification of the pairing relationship using a distance map”).

Hayashi discloses two methods for measuring distance between two occlusion surfaces: (1) by measuring the distance in a certain direction and (2) by determining the shortest distance. Ex. 1005, 29-2. Hayashi states that

¹⁰ CAD/CAM refers to computer-aided design/computer-aided manufacturing.

the first method is “useful” under certain circumstances, but, in general, the second method, “shortest distance[,] is believed to be suitable.” *Id.* The two methods are illustrated in Figure 1, which is reproduced below:

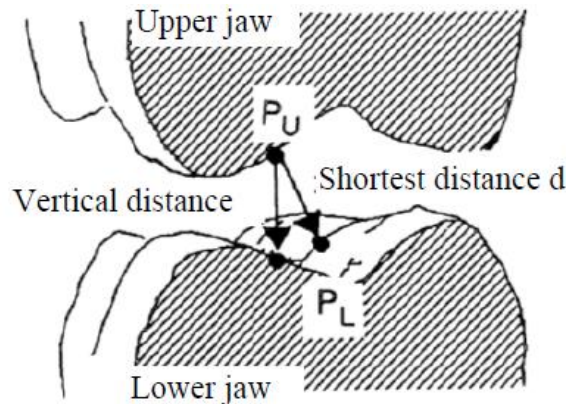


Figure 1 Interocclusal distance at points on the occlusion surface

Ex. 1005, 29-2. Hayashi Figure 1 illustrates two ways to measure the interocclusal distance at points on the occlusion surfaces of the upper and lower jaws. *Id.* (Figure 1 caption and labels). As illustrated in Figure 1, the first way is to measure the vertical distance between a point P_U on the upper jaw surface and the lower jaw surface, and the second way is to measure the shortest distance d between the point P_U and a point P_L on the lower jaw surface. *Id.*

According to Hayashi, “[t]he authors defined the shortest distance between a point on the occlusion surface and the opposite occlusion surface as the interocclusal distance for that point.” Ex. 1005, 29-2. Hayashi uses the term “distance map” to refer to the distribution of interocclusal distances, i.e., shortest distances, for all points on the occlusion surface. *Id.* An example of such a distance map is shown in Figure 2, which is reproduced below.

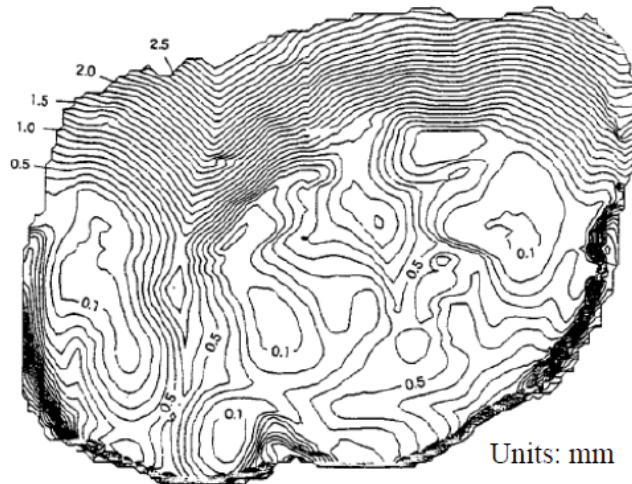


Figure 2 Distance map on the occlusion surface
The interocclusal distance on the upper jaw first molar occlusion surface is shown as a contour line.

Ex. 1005, 30-1. Hayashi Figure 2 shows a distance map for the upper jaw first molar, where the interocclusal distances are shown as contour lines. *Id.* at 29-2, 30 (Figure 2 caption). Hayashi discloses that a distance map like Figure 2 makes it possible to “determine which site of the occlusion surface is being touched, and which site is close without making any contact.” *Id.* at 30-1.

Hayashi proposes a method for analyzing the pairing relationship between occlusion surfaces, including sites that are not in contact. Ex. 1005, 27-1, 30-2 (§ 3.3, “Evaluation of the pairing relationship using the proximity”). Hayashi discloses:

The contact region on a certain occlusion surface S will be the region in which the interocclusal distance d on the occlusion surface will be zero. In this case, if the interocclusal distance d is not zero, but is equal to or less than a certain value x mm, it will be possible to target a broader region that includes the contact region. . . .

Id. at 30-2. Hayashi’s analysis method is shown in Figure 4, which is reproduced below.

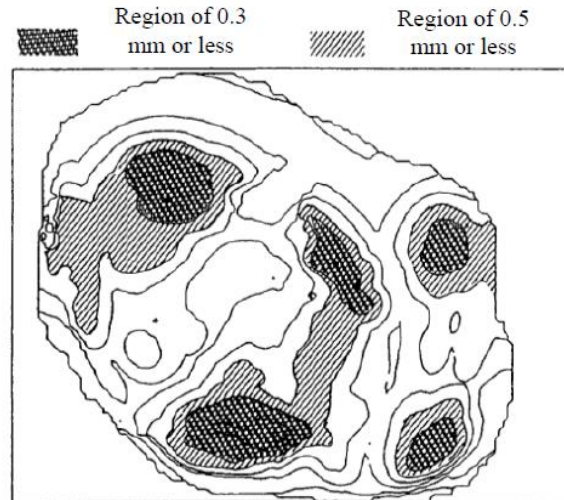


Figure 4 Region $R(x)$ of x mm or less on the occlusion surface $R(0.3)$ and $R(0.5)$ are shown using diagonal lines.

Ex. 1005, 31-1. Hayashi Figure 4 shows an occlusion surface that is shaded to identify regions having an interocclusal distance of 0.3 mm or less and regions having an interocclusal distance of 0.5 mm or less. *Id.* at 30-2, 31-1 (Figure 4 caption).

Hayashi discloses an analysis of the pairing relation of the first molars during lateral sliding movement using proximity. Ex. 1005, 32-1 (§§ 4, 4.1). The results of this analysis are shown in Figure 11, which is reproduced below.

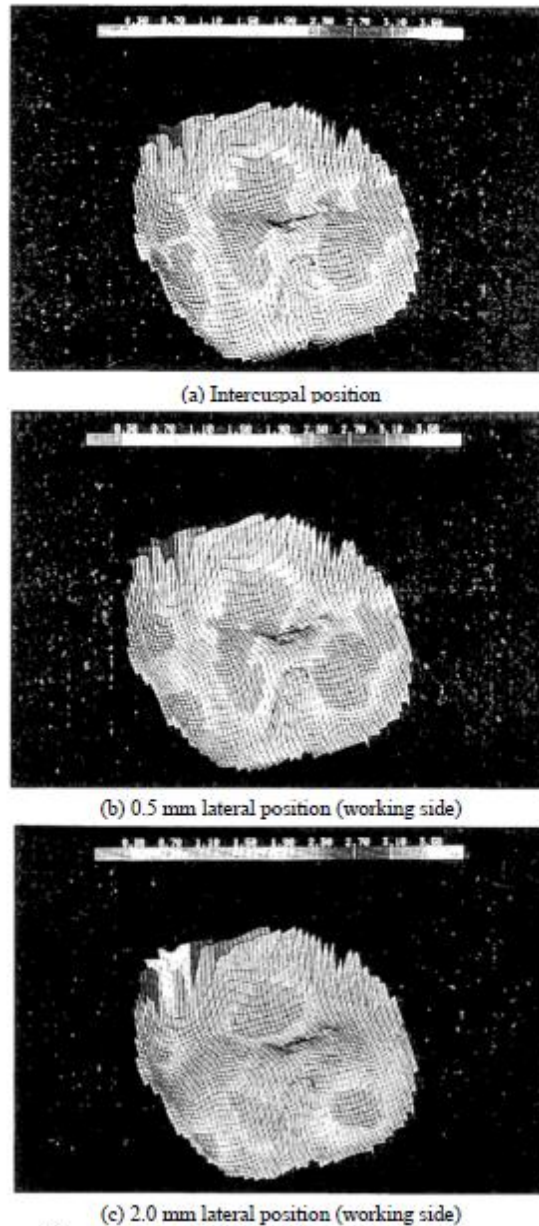


Figure 11 Example of the changes in the distance map accompanying lateral sliding movement

Ex. 1005, 34-1. Hayashi Figure 11 illustrates an example of the changes in the distance map accompanying a lateral sliding movement. *Id.* (Figure 11 caption). Hayashi provides the following description of Figure 11:

Figures 11 (a) – (c) show an example of the changes in the distance map accompanying lateral sliding movement. The shape of the upper jaw first molar was represented using a wire frame, and the interocclusal distance d is shown using false

colors. At the intercuspal position, region R (0.3) with a interocclusal distance of 0.3 mm or less is broadly present on the inclined plane within the dental cusp (Figure 11 (a)), but it gradually decreased accompanying lateral movement (Figures 11 (b), (c)). At the 2.0 mm lateral position (working side), R (0.3) was observed only in the inclined plane within the buccal cusp and the tip of the palatal cusp (Figure 11 (c)).

Ex. 1005, 33-2.

E. Petitioner's Ground 1: Kunii Anticipation

Petitioner contends that claims 1–3, 5, 7, and 9–11 of the '853 Patent are unpatentable as anticipated by Kunii. Pet. 31–50. Patent Owner opposes. PO Resp. 18–26. We address the parties' arguments below.

1. Claim 1

a) "distances between opposite regions"

The claim 1 preamble recites: "A method for obtaining a dental occlusion map of a three-dimensional virtual computer model of teeth of upper and lower jaws of a mouth, said occlusion map indicative of **distances between opposite regions** on facing surfaces of opposite teeth of the upper and lower jaws of the mouth, said method comprising the steps of."

Ex. 1001, 7:53–8:2 (emphasis added). Step (i) of claim 1 recites: "determining said **distances between opposite regions** on opposite teeth of the upper and lower jaws of the mouth." *Id.* at 8:2–5 (emphasis added). The parties dispute whether Kunii discloses "distances between opposite regions," as recited in claim 1. Pet. 33, 36–38; PO Resp. 18–22.

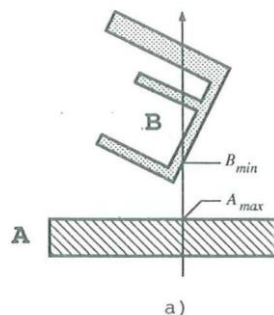
Petitioner relies on Kunii Figure 1a and Kunii's description of measuring distance "along a fixed projection direction" to show that Kunii discloses determining "distances between opposite regions on opposite teeth." Pet. 33, 36–38 (addressing the preamble and step (i) of claim 1 and

citing Ex. 1003, 164-1). Petitioner contends that the objects in Kunii Figure 1a “can be facing surfaces of opposite teeth.” *Id.* at 36 (citing Ex. 1003, 163-2, 166-1). Petitioner relies on Kunii’s disclosure of determining “distances between points on surfaces of these objects” including “surfaces of the upper and lower jaw.” Pet. 37 (quoting Ex.1003, 164-1). Petitioner contends that “Kunii’s teaching of determining distances ‘along a fixed projection direction’ anticipates the claims under [Patent Owner]’s construction.” Reply 8.

Relying on its proposed construction for “opposite regions,” Patent Owner argues that Kunii does not disclose “determining distances between opposite regions on opposite teeth.” PO Resp. 18–22; Sur-Reply 10–14.

After considering both parties’ arguments, we find that Petitioner has shown by a preponderance of the evidence that Kunii discloses determining and mapping “distances between opposite regions [on facing surfaces of] opposite teeth of the upper and lower jaws of the mouth,” as recited in the preamble and step (i) of claim 1, even under Patent Owner’s construction for “opposite regions.”

Our finding is based on the distance determination illustrated by Kunii Figure 1a, which is reproduced below.



Ex. 1003, 164. Kunii Figure 1a illustrates the calculation of distance between objects A and B along a fixed projection direction. *Id.* (caption of

Figure 1). According to Kunii, “in the simplest case, the distance is measured along a fixed projection direction.” *Id.* at 164-1.

Patent Owner’s construction for “opposite regions” provides in pertinent part: “[p]oints . . . [on (facing surfaces of) opposite teeth] that intersect the same z-axis line.” PO Resp. 9.¹¹ We find that Kunii Figure 1a discloses points on opposite teeth (points A_{max} and B_{min}) that intersect the same z-axis line (the upward pointing arrow representing the “projection direction”), thus satisfying Patent Owner’s construction. We agree with Petitioner that Kunii Figure 1a shows determining distances along a z-axis line in the same way as shown in Figure 2 of the ’853 Patent. Reply 9. Petitioner is also correct that Kunii Figure 6 shows orienting the z-axis relative to a dental model in the same way as shown in Figure 1 of the ’853 Patent. *Id.* at 9–10. To the extent “z-axis” in Patent Owner’s construction refers to an axis perpendicular to the occlusion plane (see Ex. 1001, 3:48–50), that feature is also disclosed by Kunii. Ex. 1003, 164-2 (“[T]he projection directions . . . close to the normal vector to the occlusal surface [are] the most informative directions”); *id.* at Fig. 6 (showing Cartesian coordinate system with z-axis perpendicular to the occlusion plane).

Our finding is also based on Kunii’s disclosure of using a “single projection technique” to calculate “distance images” and “distance maps.”

¹¹ Patent Owner’s full construction is: “[p]oints and/or the circular, elliptic, or irregular shape surrounding points [on (facing surfaces of) opposite teeth] that intersect the same z-axis line.” PO Resp. 9. In view of the “and/or” in Patent Owner’s construction, it is sufficient to consider the distance between “points . . . that intersect the same z-axis line,” without the need to consider the distance between “regions,” i.e., “the circular, elliptic, or irregular shape surrounding points.” *Id.*

Ex. 1003, 163–167, Figs. 3a, 4. Kunii discloses that the “single projection technique” involves calculating distance between points on one jaw and corresponding points on the opposite jaw, using a single projection direction for all points. *Id.* at 164-2–165-1; *see also id.* at 165-2 (comparing amount of time needed to calculate a distance map using “the single projection technique” and “the multiprojection technique”); *see also id.* at 166-1 (In Kunii Figure 4, “[i]mages on the left were obtained using single projection technique, and the ones on the right were produced using 13 projection directions.”).

Patent Owner argues that objects A and B in Kunii Figure 1 “are not teeth and do not represent opposite regions on opposite teeth or jaws.” PO Resp. 19. We disagree. Petitioner is correct that objects A and B in Kunii Figure 1a “can be facing surfaces of opposite teeth.” Pet. 36. The caption below Kunii Figure 1 states: “[c]alculation of distance $d = B_{min} - A_{max}$ between objects A and B along projection direction.” Ex. 1003, 164. Kunii discloses that objects A and B can be “any complex objects,” including “the surfaces of the upper and lower jaw.” *Id.* at 164-1. Kunii further discloses that models of such jaw surfaces are “derived from scanning the casts of teeth.” *Id.* at 164-2. The evidence is overwhelming that Kunii Figure 1a illustrates a method for determining the distance between opposite points on opposite teeth of opposite jaws, even though the objects shown in the figure are not teeth.

Patent Owner argues that “Kunii does not disclose directly measuring the distances between opposite teeth, but instead measures interaction of teeth with other foreign objects.” PO Resp. 21; *id.* at 23 (same argument). Patent Owner’s argument is belied by the excerpts from Kunii quoted in the preceding paragraph, which show that objects A and B can be the surfaces of

the upper and lower jaws and teeth. Ex. 1003, 164-1, 164-2. Patent Owner's argument is also belied by Kunii's disclosure of distance maps for the purpose of evaluating occlusion and estimating the interaction between teeth. *Id.* at 163-2 ("Our basic idea for evaluation of occlusion is to estimate interaction between teeth using *distance maps* . . ."); *id.* at 166-1 ("Let us . . . consider the distance map of the surface S of a given tooth[;] . . . *the contact area* [is] the set M of all points in S that are within [a threshold value] δ from some tooth in the other jaw . . ."). Patent Owner's argument also disregards Kunii Figure 3a and the left side of Kunii Figure 4, both of which use various colors to show distances between opposite points on the surface of opposite teeth. Ex. 1003, 165 (Fig. 3a), 164-2-165-1, 166-1, 167 (Fig. 4).

Patent Owner argues that Kunii "does not match 'opposite' triangles or polygons along common z-axis grid lines" and that "Kunii's triangles or polygons are not points, nor are they circular, elliptical, or irregular shapes surrounding points." PO Resp. 22 (citing Ex. 1003, 164-2, Fig. 2); *see also* Sur-Reply 14 (similar argument). Patent Owner's argument is not sufficient to rebut Petitioner's showing that Kunii discloses determining distances between opposite points on opposite teeth (e.g., points A_{max} and B_{min} in Kunii Figure 1a) that intersect the same z-axis line (e.g., the "projection direction" in Kunii Figure 1). Under Patent Owner's claim construction, it is irrelevant whether or not Kunii matches ***opposite triangles or polygons*** along common z-axis grid lines. Determining the distance between ***opposite points*** that intersect the same z-axis line meets the claim limitation under Patent Owner's construction. *See supra*, note 10, at 30.

Next, Patent Owner argues that "Kunii's fixed projection direction discussion does not disclose the claimed method because the claimed

method does not use a fixed projection direction.” Sur-Reply 13. According to Patent Owner, “z-axis gridlines are not projections” because “projection directions cannot distinguish between collision and non-collision situations.” *Id.* Patent Owner’s argument is not sufficient to rebut Petitioner’s showing that Kunii discloses “determining distances between opposite regions,” even under Patent Owner’s claim construction.

We see no requirement either in claim 1 or in Patent Owner’s construction for distinguishing between collision and non-collision situations. Patent Owner relies on the “z-axis line” in its construction, but does not explain how a “z-axis line” distinguishes between collision and non-collision situations. In a related vein, Patent Owner argues that “the methodology used to measure distances in the ’853 patent would not generate negative distances, as the ’853 patent describes and depicts solid teeth, which stop advancing toward each other at a point of contact (zero distance).” PO Resp. 20. Patent Owner’s argument applies equally to Kunii, which likewise discloses measuring distance between solid teeth, which stop advancing toward each other at a point of contact. *See, e.g.*, Ex. 1003, 164-1, Figs. 2, 3, 4, 6. Because the distinctions argued by Patent Owner are not supported by the claim language or even its own claim construction, they are not sufficient to rebut Petitioner’s evidence.

b) “occlusion map”

The claim 1 preamble recites: “[a] method for obtaining a dental **occlusion map** . . . said **occlusion map** indicative of distances between opposite regions on facing surfaces of opposite teeth of the upper and lower jaws of the mouth.” Ex. 1001, 7:53–8:1 (emphasis added). Petitioner contends that Kunii’s “distance image” and “distance map” are each an

“occlusion map,” as recited in the preamble of claim 1. Pet. 31–32, 40–42 (citing Ex. 1003, 163–166, Figs. 3a, 3b, 4).

Patent Owner argues that “Kunii’s use of multiple projections results in a ‘distance map’ that is fundamentally different from the recited ‘occlusion map.’” PO Resp. 22–25.

As discussed above, we adopt Petitioner’s proposed construction for “occlusion map” as a “‘graphical representation of the distance between opposite points, or regions, on the surface of opposite teeth’ and encompasses a two-dimensional graphical representation.” Pet. 29. After considering both parties’ arguments, we find that Petitioner has shown by a preponderance of the evidence that Kunii’s “distance images” and “distance maps” are “occlusion maps,” as that term has been construed.

Our finding is supported by Kunii’s description of “distance images” and “distance maps” as graphical representations of distances “between the surfaces of the upper and lower jaw.” Ex. 1003, 164-1; *see also id.* at 164, Fig. 3a (“Graphical display of a distance image”); *id.* at 166-1 (“Let us . . . consider the distance map of the surface S of a given tooth[;] . . . *the contact area* [is] the set M of all points in S that are within [a threshold value] δ from some tooth in the other jaw”); *id.* at 168, Fig. 4 (“Distance map in the surface of a molar tooth”).

Kunii Figure 3a, for example, is a “distance image” in which distance values for a single projection direction are represented graphically.

Ex. 1003, 164–2–165-1. Kunii describes Figure 3a as follows:

Fig. 3a shows an example of a distance image: pink and white regions correspond to areas in lower and upper jaws, respectively, that have no corresponding point in the opposite jaw in the direction of the current projection; regions marked by blue and green are those where the distance in the projection

direction between the jaws exceeds 1 mm, and borders between green and yellow correspond to distances below 1 mm; colors between yellow and red correspond to distances below 1 mm; zero distance, i.e., contact between the surfaces, would be pure red.

Id. at 165-1; *see* Pet. 40–41 (quoting same disclosure from Kunii).

According to the foregoing disclosure in Kunii, each colored region, e.g., blue, green, yellow, or red, corresponds to a given distance or range of distances between opposite points on the upper and lower jaw surfaces. *Id.* This corresponds very closely to the '853 Patent's description of an "occlusion map" as comprising "colored regions, where each color corresponds to a given distance, or range of distances, between opposite points or regions on the surface of opposite teeth." Ex. 1001, 1:66–2:2.

We find that the above passage describing Kunii Figure 3a refers to distance in a single projection direction—"the direction of the current projection"—which may be the z-axis direction. Ex. 1003, 165-1; *see also id.* at Figs. 1a, 6 (illustrating distance between points on the surfaces of the upper and lower jaws in single projection direction, for example, in the z-axis direction); *id.* at 164-2 (projection direction may be "the normal vector to the occlusal surface"). When distances are between the upper and lower jaws are determined in the z-axis direction, the resulting distances are "between opposite points, or regions, on the surface of opposite teeth," as set forth in Petitioner's construction for "occlusion map." Pet. 29.

Our finding is also supported by Kunii Figure 4, which "shows distance maps found for the upper left first molar for two positions of the lower jaw." Ex. 1003, 166-1. Like Kunii Figure 3a, the images on the left side of Kunii Figure 4 "were obtained using single projection technique." *Id.* As discussed above, the reference to a "single projection technique" in

the context of Kunii as a whole means that the distances represented in the distance map on the left side of Kunii Figure 4 are between opposite points on the surface of opposite teeth, as set forth in Petitioner's construction for "occlusion map."

Patent Owner argues that "Kunii discloses a 'distance map' with 'multiple projections' that does not use the term 'opposite region' at all." PO Resp. 22; *see also id.* at 23 (discussing Kunii's disclosures regarding "multiple projections"). Patent Owner's arguments disregard the fact that Kunii discloses a "distance map" obtained using "a single projection technique." Ex. 1003, 166-1, Fig. 4 (left side). Patent Owner's argument also disregards its own claim construction, which defines "opposite regions" as "points . . . that intersect the same z-axis line." Under that construction, the absence of an express discussion of "opposite regions" in Kunii is not persuasive. *See supra* note 10, at 30.

Next, Patent Owner argues that "Kunii . . . measures interaction of teeth with other foreign objects," including interaction with food particles during chewing. PO Resp. 23. Again, those arguments ignore the disclosures of Kunii relied upon by Petitioner to show an "occlusion map" (Pet. 31–32, 40–42), including the "distance image" of Kunii Figure 3a and the "distance map" on the left side of Kunii Figure 4, both of which use various colors to show distances between opposite points on the surface of opposite teeth. Ex. 1003, 165 (Fig. 3a), 164–2–165-1, 166-1, 167 (Fig. 4).

Next, Patent Owner argues without elaboration that "FIG. 1 of Kunii shows a separate embodiment from the 'distance map' techniques on which Petitioner relies to allege anticipation." PO Resp. 24. We disagree. As discussed above, Kunii Figure 1a illustrates determining distance using a "fixed projection direction," which is the same technique as Kunii discloses

was used to produce the “distance image” of Kunii Figure 3a and the “distance map” on the left side of Kunii Figure 4. Ex. 1003, 164-1, 164-2–165-1, 166-1.

Referring to Kunii’s description of Figure 5, Patent Owner argues that “Kunii thus generates a different kind of map using a different method for a different purpose from that of the ’853 patent.” PO Resp. 24; *see also id.* at 25 (discussing Kunii’s use of multiple projections to animate and simulate dynamic movement). Patent Owner’s argument disregards the relevant disclosures of Kunii that are relied upon by Petitioner to show an “occlusion map.” Patent Owner does not succeed in rebutting Petitioner’s showing by directing us to portions of Kunii that are not relied upon by Petitioner and are not relevant to the ’853 Patent claims.

Next, Patent Owner argues “[n]owhere does Kunii describe any point, or shape surrounding a point, as any region that corresponds to an opposite region on an opposite tooth, along any one axis.” PO Resp. 25. That argument again ignores the pertinent disclosures of Kunii, including “distance images” and “distance maps” obtained using a “single projection technique,” as well as Patent Owner’s own claim construction, which defines “opposite regions” as “points . . . that intersect the same z-axis line.” Ex. 1003, 165 (Fig. 3a), 164–2–165-1, 166-1, 167 (Fig. 4).

Accordingly, Patent Owner’s arguments are not persuasive to rebut Petitioner’s showing that Kunii discloses an “occlusion map,” as recited in claim 1 of the ’853 Patent.

c) Remaining elements of claim 1

The preamble of claim 1 recites that the dental occlusion map is “of a three-dimensional virtual computer model of teeth of upper and lower jaws

of a mouth.” Ex. 1001, 7:52–54. Petitioner contends that “Kunii’s distance map is of a three-dimensional virtual computer model of teeth of upper and lower jaws of a mouth.” Pet. 34. Patent Owner does not dispute Petitioner’s contention.

We find that Petitioner’s contention is supported by Kunii, which discloses that distances are calculated from “models of jaws derived from scanning the casts of teeth.” Ex. 1003, 164-2. According to Kunii, the distance between the jaws is “calculated as the difference d between the minimal depth B_{min} recorded when the first [jaw] is scan-converted, and the corresponding maximal depth A_{max} for the second [jaw].” *Id.*; *see also id.* at 163-2 (“The work was done with real data [including] scanned surfaces of the upper and lower jaw”); *id.* at 164-1 (Figure 2 showing digital model of occlusal surface of jaw); *id.* at 166-2 (“In this work we examine these [distance-based] characteristics using real data, namely, the scanned shape of the teeth”). There is no dispute that Kunii’s models of jaws and teeth are three-dimensional, a fact supported by Kunii’s disclosure that the models include depths and are used to calculate distance. *Id.* at 164-2, 166-2. There is also no dispute that Kunii’s distance calculations are used to make “distance images” and “distance maps.” *Id.* at 164–165 (section “2 Calculation of distance maps”).

Step (ii) of claim 1 recites: “setting up a correspondence between said determined distances and regions on a mapping surface.” Petitioner contends that Kunii discloses relating a distance to a corresponding color on a color scale and setting up a correspondence between the distances and colored regions on a mapping surface. Pet. 40. Aside from the arguments already discussed above, Patent Owner does not specifically dispute Petitioner’s contention regarding step (ii) of claim 1.

We find that Petitioner's contention is supported by the "distance image" shown in Kunii Figure 3a and the "distance map" shown in Kunii Figure 4. Kunii discloses that, in Figure 3a, each colored region on the distance image, e.g., blue, green, yellow, or red, corresponds to a given distance or range of distances between opposite points on the upper and lower jaw surfaces. Ex. 1003, 165-1. A similar correspondence was set up for the "distance map" in Kunii Figure 4. *Id.* at 166-1, 167 (Fig. 4).

d) Conclusion regarding claim 1

Petitioner has shown by a preponderance of the evidence that Kunii discloses all limitations of claim 1.

2. Claim 2

Claim 2 depends from claim 1 and recites: "wherein said mapping surface is a plane, whereby said dental occlusion map is a two-dimensional map of the distances between said opposite regions on said opposite teeth." Ex. 1001, 8:7-11.

Petitioner contends that, in Kunii Figure 3a, "the mapping surface is a plane because it is a two-dimensional map." Pet. 43-44 (citing Ex. 1003, Fig. 3a; Ex. 1006 ¶ 76). Patent Owner presents no argument regarding dependent claim 2 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18-26.

We find that Petitioner's contention regarding dependent claim 2 is supported by Kunii Figure 3a, which is a two-dimensional image. Ex. 1003, 165 (Fig. 3a). Petitioner's contention is also supported by Dr. Egbert's testimony that Kunii Figure 3a depicts a two-dimensional map. Ex. 1006 ¶ 76.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 2.

3. *Claim 3*

Claim 3 depends from claim 1 and recites: “wherein said mapping surface is a facing surface of said facing surfaces of opposite teeth of the upper and lower jaws of the mouth.” Ex. 1001, 8:12–15.

Petitioner contends that “Kunii discloses occlusion maps where the mapping surface is a facing surface of the facing surfaces of opposite teeth of the upper and lower jaw.” Pet. 44–45 (citing Ex. 1003, Figs. 3b, 4; Ex. 1006 ¶ 79).

Patent Owner presents no argument regarding dependent claim 3 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

We find that Petitioner’s contention regarding dependent claim 3 is supported by Kunii, which discloses that, in Kunii Figure 4, the surface on which a correspondence between distances and regions is set up (i.e., the mapping surface) is a surface of “the upper left first molar.” Ex. 1003, 166–1. Petitioner’s contention is also supported by the testimony of Dr. Egbert, who provides the same interpretation of Kunii’s disclosure. Ex. 1006 ¶ 79.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 3.

4. *Claim 5*

Claim 5 depends from claim 3 and recites: “wherein said facing surface belongs to the teeth of said upper jaw, and said lower teeth and lower jaw are not present.” Ex. 1001, 8:20–23.

Petitioner contends that the limitation of claim 5 is disclosed, e.g., by Kunii Figure 4, which “shows distance maps found for the upper left first molar for two positions of the lower jaw.” Pet. 46 (quoting Ex. 1003, 166-1). Petitioner contends that, in Kunii Figure 4, “the facing surface (surface of ‘the upper left first molar’) belongs to the teeth of the upper jaw” and “the lower teeth and lower jaw are not shown and therefore are not present.” *Id.* (citing Ex. 1006 ¶ 82).

Patent Owner presents no argument regarding dependent claim 5 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

We find that Petitioner’s contention regarding dependent claim 5 is supported by the cited portions of Kunii, as well as the cited testimony of Dr. Egbert, who supports Petitioner’s understanding of Kunii. Pet. 46; Ex. 1003, 166-1; Ex. 1006 ¶ 82.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 5.

5. *Claim 7*

Claim 7 depends from claim 3 and recites: “wherein said facing surface belongs to the teeth of said lower jaw, and said upper teeth and upper jaw are not present.” Ex. 1001, 8:28–31.

Petitioner contends that Kunii discloses that a distance map (occlusion map) is mapped onto the facing surface of the **lower tooth** in the same manner as the distance map (occlusion map) is mapped onto the facing surface of **the upper tooth**. Pet. 47–48 (citing Ex. 1003, 164-2, 165-1, 165-2, 166-1).

Patent Owner presents no argument regarding dependent claim 7 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

Claim 7 is similar to claim 5, except that the words “upper” and “lower” are reversed in claim 7 as compared with claim 5. Kunii Figure 4 shows the limitation of claim 5, i.e., the mapping surface is a facing surface belonging to the teeth of the upper jaw, and the lower teeth and lower jaw are not present. We find that Petitioner has shown that Kunii discloses that the surface of the teeth of ***either the upper or the lower jaw*** can be shown in Kunii’s “distance maps,” thus meeting the limitation claim 7.

Petitioner’s contention regarding claim 7 is supported by Kunii, which discloses “project[ing] the distance image back into the object space.” Ex. 1003, 165-1. We understand Kunii’s “object space” to be a representation of the surface of the teeth of either jaw. Petitioner’s contention is further supported by the following passage from Kunii:

As a result of back-projection the *distance maps* for ***every surface*** are produced; we call the *distance map* the function ***on the surface of one of the objects*** (or a graphical representation of this function) whose value at a point of the surface is equal to the distance from the other surface.

Ex. 1003, 165-2 (emphasis added); *see* Pet. 48 (relying on this passage). In the above-quoted passage, “the objects” refers to the upper and lower jaws and teeth. *Id.* at 165-1, Figs. 3a, 3b. We agree with Petitioner and Dr. Egbert that, in the above-quoted passage, “every surface” includes a facing surface belonging to the teeth of the lower jaw. Pet. 48; Ex. 1006 ¶ 86. According to this passage from Kunii, the distances between the surfaces of two objects can be mapped on “the surface of one of the objects,”

i.e., ***either*** on the surface of the upper jaw and teeth ***or*** on the surface of the lower jaw and teeth. Ex. 1003, 165-2.

Petitioner’s contention is further supported by Dr. Egbert’s interpretation of the above-quoted passage from Kunii that “[w]hen such occlusion map is mapped onto the facing surface of the lower tooth (in the same manner as the occlusion map is mapped onto the facing surface of the upper tooth), said upper teeth and upper jaw are not present.” Ex. 1006 ¶ 86.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 7.

6. *Claim 9*

Claim 9 depends from claim 1 and recites: “wherein said opposite regions on said facing surfaces of opposite teeth are colored in accordance with a given color scale and wherein each color corresponds to a given distance.” Ex. 1001, 8:37–41.

Petitioner contends that Kunii discloses that opposite regions on said facing surfaces of opposite teeth are colored in accordance with a given color scale. Pet. 49 (citing Ex. 1003, 165-1; Ex. 1006 ¶ 90).

Patent Owner presents no argument regarding dependent claim 9 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

We find that Petitioner’s contention regarding dependent claim 9 is supported by Kunii, which discloses that, in Figure 3a, each colored region on the distance image, e.g., blue, green, yellow, or red, corresponds to a given distance or range of distances between opposite points on the upper and lower jaw surfaces. Ex. 1003, 165-1.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 9.

7. Claim 10

Claim 10 depends from claim 1 and recites: “wherein said opposite regions on said facing surfaces of opposite teeth are points.” Ex. 1001, 8:42–44.

Petitioner contends that Kunii discloses determining “distances between points on surfaces of these objects” including “surfaces of the upper and lower jaw.” Pet. 50 (quoting Ex. 1003, 164-1). Petitioner directs us to other portions of Kunii that discuss determining distances between points on the surfaces of objects or teeth. *Id.* (citing Ex. 1003, 163-2, 164-1; Ex. 1006 ¶ 92).

Patent Owner presents no argument regarding dependent claim 10 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

We find that Petitioner’s contention regarding dependent claim 10 is supported by the cited portions of Kunii, as well as the cited testimony of Dr. Egbert, who supports Petitioner’s understanding of Kunii. Ex. 1003, 163-2, 164-1; Ex. 1006 ¶ 92.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 10.

8. Claim 11

Claim 11 depends from claim 1 and recites: “wherein said regions on said mapping surface comprise at least one pixel.” Ex. 1001, 8:45–47.

Petitioner contends that Kunii Figure 3a “shows a graphical display of a distance image, the distance image of the graphical display includes at

least one pixel because an image is made up of pixels,” and that the pixels in Figure 3a “are colored according to the corresponding distances between the opposite jaws.” Pet. 50 (citing Ex. 1003, 165-1; Ex. 1006, ¶ 94).

Patent Owner presents no argument regarding dependent claim 11 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 18–26.

We find that Petitioner’s contention regarding dependent claim 11, including its interpretation of Kunii Figure 3a, is supported by Kunii and the cited testimony of Dr. Egbert. Ex. 1003, 165-1; Ex. 1006, ¶ 94.

Accordingly, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitation of claim 11.

9. Conclusion regarding Petitioner’s Ground 1

Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7, and 9–11 of the ’853 Patent are unpatentable as anticipated by Kunii.

F. Petitioner’s Ground 2: Kunii Obviousness

Petitioner contends that claims 1–3, 5, 7, and 9–11 of the ’853 Patent are unpatentable as obvious in view of Kunii. Pet. 51–55. Patent Owner opposes. PO Resp. 26–31. We address the parties’ arguments below.

1. Claim 1

Petitioner argues that, if claim 1 is construed to require that distances be measured in a fixed projection direction and if Patent Owner argues that no single embodiment of Kunii discloses that feature, then “it would have been obvious at the time of the purported invention to modify Kunii to measure distances along a fixed projection direction.” Pet. 51. Petitioner contends that a POSITA would have been motivated to modify Kunii’s

occlusion map by determining distances in a fixed projection direction to obtain the predictable benefit of simpler and faster calculations. *Id.* at 52–53.

Patent Owner argues that Petitioner’s obviousness analysis misconstrues the scope of the claims and that a POSITA would not have been motivated to modify Kunii to arrive at the challenged claims. PO Resp. 26–31.

After considering both parties’ arguments, we find that Petitioner has shown by a preponderance of the evidence that the subject matter of claim 1 would have been obvious to a POSITA, even under Patent Owner’s construction for “opposite regions” and even if Kunii’s “fixed projection direction” method as illustrated in Figure 1a was considered a separate embodiment from the “single projection technique” used to generate the maps shown in Kunii Figures 3a and 4.

Petitioner has shown that Kunii discloses determining a distance between points on the surfaces of two objects along a fixed projection direction. Pet. 33, 36–38, 51; Ex. 1003, Fig. 1a, 164-1 (“[I]n the simplest case, the distance [between points on the surfaces of complex objects] is measured along a fixed projection direction”). Petitioner has also shown that it would have been obvious in view of Kunii to use the fixed projection direction method to determine distances between opposite regions on opposite teeth of the upper and lower jaws. Pet. 51–53 (citing Ex. 1003, 164–165, Fig. 4; Ex. 1006 ¶¶ 96–100). We find that a preponderance of the evidence establishes a motivation and a reasonable expectation of success for Petitioner’s modification. In this regard, we credit the following testimony of Dr. Egbert:

[A] POSITA would have been motivated to modify Kunii to determine distances in a fixed projection direction to obtain an occlusion map because a POSITA would have recognized that predictable benefits of such a modification would include simpler calculations for obtaining occlusion maps that may be obtained in less time. . . . A POSITA would have had a reasonable expectation of success because Kunii discloses that the “simplest case” is to measure distance along a fixed projection direction. . . . A POSITA would have recognized that the technique disclosed by Kunii would have readily been applicable to Kunii because Kunii discloses each of the techniques of determining distance along a fixed projection direction, a single projection direction, and multiprojection directions for providing distance information of contact areas of opposing teeth.

Ex. 1006 ¶ 98(citing Ex. 1003, 164–165).

Responding to Petitioner’s obviousness case, Patent Owner is ambivalent about whether Kunii’s “fixed projection direction” differs from distance determination required by the ’853 Patent claims. First, Patent Owner attempts to distinguish Kunii’s “fixed projection direction” from the claims, arguing that “distances ‘measured along a fixed projection direction’ . . . are not the same as distances measured along ‘parallel grid lines’ at their intersections with jaw surfaces.” PO Resp. 27 (citing Ex. 1001, 3:45–51, Figs. 1, 2, 6). Second, Patent Owner implies that a “fixed projection direction” is the same as what is claimed, when it argues: “[n]othing in Kunii teaches a POSITA to generate an occlusion map showing distances between opposite regions on opposite teeth measured along one fixed production [*sic*, projection] direction.” *Id.*

We disagree with both arguments. Patent Owner provides no basis for distinguishing Kunii’s “fixed projection direction” from the ’853 Patent’s parallel grid lines or Patent Owner’s construction for “opposite regions.”

For the reasons discussed above, we find that Kunii’s disclosure of a “fixed projection direction” and “single projection technique” satisfies Patent Owner’s claim construction. See Section II.E.1.a, *supra*. Patent Owner’s argument about Kunii disregards Kunii’s teaching that distance images and distance maps, i.e., an occlusion map, can be generated by measuring the distance between jaw surfaces in a “fixed projection direction,” which Kunii refers to as a “single projection technique.” Ex. 1003, 165 (Fig. 3a), 164–2–165-1, 166-1, 167 (Fig. 4).

Next, Patent Owner argues “the claimed methods would have allowed more reliable pixel mappings, especially in the absence of rich data collection” and “[n]othing in Kunii relates to sparse grid lines or spaced pixels.” PO Resp. 28 (citing Ex. 1001, 7:12–17). Patent Owner’s arguments are not based on any limitation in claim 1, nor any claim construction proposed by the parties. We decline to read into the claim a requirement for reliability or precision. See *In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993) (rejecting appellant’s nonobviousness argument as based on a limitation not expressly recited in the claim, stating “limitations are not to be read into the claims from the specification”).

Next, Patent Owner argues that Kunii teaches away from mapping distances measured along a fixed projection direction. PO Resp. 28–31 (citing Ex. 2004 ¶¶ 65–67). According to Patent Owner, Kunii “disparages this technique as causing the results to be ‘strongly affected by the choice of this direction’ and therefore not as much of a ‘reliable distance measure’ as when using multiple directions and minimal distances.” *Id.* at 29 (quoting Ex. 1003, 164-2).

We agree with Petitioner that Kunii’s expressed preference for a “multiprojection technique,” as compared with a “single projection

technique,” does not negate obviousness under the applicable legal standard. Reply 16 (citing *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (“[O]ur case law does not require that a particular combination must be the preferred, or the most desirable, combination described in the prior art in order to provide motivation.”)). Kunii expresses a preference for a “multiprojection technique,” but that preference does not amount to a teaching away from a “fixed projection direction” or “single projection technique,” for which Kunii teaches other advantages. Ex. 1003, 164-1, 165-2. We addressed this issue in the Institution Decision, where we stated:

Kunii teaches that measuring distance “along a fixed projection direction” is one way to measure distance between the occlusal surfaces of the upper and lower jaws and refers to that method as the “single projection technique.” Ex. 1003, 164, 165-2, 166-1, Figs. 1a, 2. Kunii expresses a preference for a measurement method that considers multiple directions, stating it is a “more reliable distance measure,” “allows detection of more active regions,” and “yields a more accurate distance map.” *Id.* at 164-1, 166-1. Nevertheless, for purposes of institution, we are persuaded that Petitioner has articulated a sufficient reason or motivation for a POSITA to measure distance along a fixed projection direction. Pet. 52. See *Bayer Pharma AG v. Watson Labs., Inc.*, 874 F. 3d 1316, 1327 (Fed. Cir. 2017) (“[T]he teaching away inquiry does not focus on whether a person of ordinary skill in the art would have merely favored one disclosed option over another disclosed option.”).

Dec. 25. Patent Owner does not identify any error in our preliminary finding regarding motivation and teaching away. Nor does Patent Owner frame its teaching away argument under the legal standard provided by the *Bayer* case cited in the Institution Decision. Dr. Bajaj testifies that “Kunii only mentions ‘a fixed projection direction’ in a separate embodiment from Kunii’s preferred embodiment of multiple projection directions.” Ex. 2004 ¶ 64. That testimony does not weigh in favor of non-obviousness under the

applicable legal standard. *Merck & Co., Inc. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989) (“[I]n a section 103 inquiry, ‘the fact that a specific [embodiment] is taught to be preferred is not controlling, since all disclosures of the prior art, including unpreferred embodiments, must be considered.’”) (quoting *In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976)).

After considering both parties’ arguments and the record developed during trial, we are persuaded that Petitioner has established a reason or motivation to modify Kunii by using a fixed projection direction to obtain an occlusion map. Pet. 52–53. Although Kunii considers a single projection technique less reliable than a multiprojection technique, Kunii also recognizes that a fixed projection direction has the advantage of allowing simpler, faster, and less expensive calculations. Ex. 1003, 164-1, 165-2.

Accordingly, Petitioner has shown by a preponderance of the evidence that the subject matter of claim 1 would have been obvious in view of Kunii.

2. *Claims 5 and 7*

Claim 3 depends from claim 1 and recites: “wherein said mapping surface is a facing surface of said facing surfaces of opposite teeth of the upper and lower jaws of the mouth.” Ex. 1001, 8:12–15. Claim 5 depends from claim 3 and recites: “wherein said facing surface belongs to the teeth of said upper jaw, and said lower teeth and lower jaw are not present.” *Id.* at 8:20–23. Claim 7 depends from claim 3 and recites: “wherein said facing surface belongs to the teeth of said lower jaw, and said upper teeth and upper jaw are not present.” *Id.* at 8:28–31. As discussed above, claim 7 is similar to claim 5, except that the words “upper” and “lower” are reversed in claim 7 as compared with claim 5.

Petitioner contends that the subject matter of claims 5 and 7 would have been obvious in view of Kunii, even if Patent Owner argues that these claims require the facing surface to correspond to surfaces of multiple teeth. Pet. 54. According to Petitioner, “while the examples of distance images and distance maps depicted in Kunii’s figures relate to a specific tooth or teeth (and a specific jaw), a POSITA would have recognized that Kunii’s techniques are equally applicable to any tooth or teeth of either jaw.” *Id.* (citing Ex. 1003, 163-1, Fig. 6). Petitioner contends that a “POSITA would have been motivated to modify Kunii’s occlusion map to provide distance information of any tooth or all of the teeth of the upper jaw or lower jaw” and “would have had a reasonable expectation of success because Kunii teaches a method for obtaining an occlusion map for a particular tooth or teeth of a particular jaw.” *Id.* at 54–55 (citing Ex. 1006 ¶ 103).

Patent Owner presents no argument regarding dependent claims 5 or 7 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 26–31.

We find that Petitioner’s arguments and evidence regarding dependent claims 5 and 7 as summarized above, including the cited portions of Kunii and Dr. Egbert’s testimony, establish obviousness of these claims. Pet. 54–55; Ex. 1003, 163-1, Fig. 6; Ex. 1006 ¶ 103.

Accordingly, Petitioner has shown by a preponderance of the evidence that the subject matter of claims 5 and 7 would have been obvious in view of Kunii.

3. *Claims 2, 3, and 9–11*

Neither party presents any argument regarding dependent claims 2, 3, or 9–11 separate from its arguments regarding obviousness for independent

claim 1 and anticipation for claims 2, 3, and 9–11. *See, generally*, Pet. 51–55; PO Resp. 26–31.

As discussed in section II.F.1 above, Petitioner has shown by a preponderance of the evidence that the subject matter of claim 1 would have been obvious in view of Kunii. As discussed in sections II.E above, Petitioner has shown by a preponderance of the evidence that Kunii discloses the limitations of claims 2, 3, and 9–11.

Accordingly, Petitioner has shown by a preponderance of the evidence that subject matter of claims 2, 3, and 9–11 would have been obvious in view of Kunii.

4. Conclusion regarding Petitioner’s Ground 2

Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7, and 9–11 of the ’853 Patent are unpatentable as obvious in view of Kunii.

G. Petitioner’s Ground 3: Kunii and Hayashi

Petitioner contends that claims 3, 5, 7, 12, and 13 of the ’853 Patent are unpatentable as obvious in view of Kunii and Hayashi. Pet. 55–66. Patent Owner opposes. PO Resp. 32–47. We address the parties’ arguments below.

1. Claims 3, 5, and 7

Claim 3 depends from claim 1 and recites: “wherein said mapping surface is a facing surface of said facing surfaces of opposite teeth of the upper and lower jaws of the mouth.” Ex. 1001, 8:12–15. Claims 5 and 7 depend from claim 3, and Petitioner relies on the same contentions for all three claims. Pet. 55–62.

Petitioner contends that, if Kunii does not disclose the subject matter of dependent claim 3, then it would have been obvious to modify Kunii in view of Hayashi to arrive at that subject matter. Pet. 56 (citing Ex. 1006 ¶ 105). Petitioner contends that the claimed “facing surface of said facing surfaces of opposite teeth” is satisfied by an outline of a tooth. *Id.* at 56–57 (citing Ex. 1001, 5:54–58, Figs. 4, 5; Ex. 1006 ¶ 106). Petitioner contends that Hayashi discloses displaying a distance map with an outline of a tooth, relying on Hayashi’s disclosure of a “wire frame” representing the shape of the upper jaw molar. *Id.* at 57–59 (citing Ex. 1005, 29–30 (§ 3.2), 33–35 (§ 4.3), Figs. 11(a)–(c); Ex. 1006 ¶¶ 107, 108). Petitioner contends that it would have been obvious to modify Kunii’s occlusion map to have an outline of a tooth as disclosed by Hayashi in order to provide additional information that would have been useful to a dentist in evaluating dental occlusion. *Id.* at 60–61 (citing Ex. 1003, 163; Ex. 1005, 29–30 (§ 3.2); Ex. 1006, ¶ 110). According to Petitioner, a “POSITA would have had a reasonable expectation of success because Hayashi discloses that providing distance information with an outline of a tooth is a viable approach to displaying distance information.” *Id.* at 61–62 (citing Ex. 1006, ¶ 111).

Patent Owner presents no argument regarding dependent claims 3, 5, or 7 separate from its arguments regarding independent claim 1. *See, generally*, PO Resp. 32–47.

We find that Petitioner’s arguments and evidence regarding dependent claims 3, 5, and 7 as summarized above, including the cited portions of Kunii, Hayashi, and Dr. Egbert’s testimony, establish obviousness of these claims. Pet. 55–62; Ex. 1003, 163; Ex. 1005, 29–30 (§ 3.2), 33–35 (§ 4.3), Figs. 11(a)–(c); Ex. 1006 ¶¶ 105–108, 110, 111.

Accordingly, Petitioner has shown by a preponderance of the evidence that the subject matter of claims 3, 5 and 7 would have been obvious in view of Kunii and Hayashi.

2. Claims 12 and 13

Claim 12 depends from claim 1 and recites: “wherein said occlusion map only shows those distances that are less than one tenth of a millimeter.” Ex. 1001, 8:48–51. Claim 13 depends from claim 1 and recites: “wherein said occlusion map only shows those distances that are zero in value.” *Id.* at 8:52–54.

Petitioner contends that Kunii discloses or suggests the limitations of claim 1 and that Hayashi discloses or suggests the limitations of claims 12 and 13. Pet. 62, 64. Petitioner relies on Hayashi Figure 4, which shows an occlusion surface that is shaded to identify regions having an interocclusal distance of 0.3 mm or less and regions having an interocclusal distance of 0.5 mm or less. Pet. 62–65; Ex. 1005, 30-2, 31-1 (Figure 4 caption). Petitioner contends that Hayashi Figure 4 is an occlusion map that only shows regions having a distance of “0.5 mm or less.” Pet. 65. Petitioner contends that Hayashi discloses a range of distances that encompasses or overlaps the claimed distances of “less than one tenth of a millimeter” (claim 12) and “zero in value” (claim 13). *Id.* Petitioner contends that, in view of Hayashi’s disclosures, it would have been obvious to modify Kunii’s occlusion map to display only the claimed distances. *Id.* at 65–66 (citing Ex. 1006 ¶¶ 116, 117).

Patent Owner argues that Hayashi does not disclose the additional limitations of claims 12 and 13 and that Petitioner provides no motivation to combine Kunii with Hayashi. PO Resp. 35–47.

After considering both parties' arguments, we find that Petitioner has shown by a preponderance of the evidence that Hayashi discloses or suggests the limitations of claims 12 and 13 and that it would have been obvious to modify Kunii's occlusion map in accordance with Hayashi's teachings. We are persuaded that Petitioner has established obviousness of claims 12 and 13 under a theory of overlapping ranges. Pet. 62–66; *E.I. du Pont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1008 (Fed. Cir. 2018) (In IPR proceedings, “where there is a range disclosed in the prior art, and the claimed invention falls within that range, the burden of production falls upon the patentee to come forward with evidence of teaching away, unexpected results or criticality, or other pertinent objective indicia indicating that the overlapping range would not have been obvious in light of that prior art.” (quoting *Galderma Labs., L.P. v. Tolmar, Inc.*, 737 F.3d 731, 738 (Fed. Cir. 2013)); see also *In re Wertheim*, 541 F.2d 257 (CCPA 1976) (“[R]anges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results.”).

Claims 12 and 13 recite numerical ranges or values, namely, “distances that are less than one tenth of a millimeter” and “distances that are zero in value.” Ex. 1001, 8:48–54. Petitioner is correct that Hayashi discloses a range—“0.5 mm or less”—that encompasses or overlaps claim 12's recitation of “less than one tenth of a millimeter” and claim 13's recitation of “zero in value.” Pet. 65; Ex. 1005, 30-2, 31-1 (Fig. 4 and its caption). In view of Petitioner's showing that the claimed subject matter falls within a range disclosed by the prior art, the burden of production shifted to Patent Owner to present evidence of teaching away, unexpected results or criticality, or other pertinent objective indicia of nonobviousness.

du Pont, 904 F.3d at 1008. Patent Owner was put on notice of this burden of production in the Institution Decision. Dec. 26.

Patent Owner attempts to carry its burden of production by identifying teachings in Hayashi that Patent Owner argues teach away from a map that “only shows those distances that are zero in value,” as recited in claim 13 or “only shows those distances that are less than one tenth of a millimeter,” as recited in claim 12. PO Resp. 38, 40–41, 43–47. According to Patent Owner, Hayashi discourages a POSITA from reducing the distances shown in the map below one tenth of a millimeter, “cautioning that as the distances become smaller, the potential for error increases, making Hayashi’s measurements less reliable with smaller interocclusal distances.” PO Resp. 43 (citing Ex. 1005, 30-2 (§ 3.2); Ex. 2003 ¶ 52; Ex. 2004 ¶ 68; Ex. 2006, 80:4–15). Patent Owner argues that Hayashi disparages techniques, like claim 13, that “analyze only contact sites” and ignore “any sites showing the slightest bit of diastasis.” *Id.* at 44 (quoting Ex. 1005, 30-2 (§ 3.3, paras. 1–3)).

After considering the parties’ arguments and evidence, we are not persuaded that Patent Owner has carried its burden of production to show teaching away, and we are persuaded that Petitioner has carried its burden of proof to show obviousness of claims 12 and 13.

We find that Hayashi discloses a method for calculating interocclusal distances and presents the results in the form of distance maps having shaded regions or contour lines representing various interocclusal distances. Ex. 1005, 29–30 (§§ 3.2, 3.3), Figs. 2, 4. Hayashi states that, with its method of calculating interocclusal distance, “as the distance narrows, there is the possibility that the relative error for the interocclusal distance will increase.” *Id.* at 30-2 (§ 3.2). Hayashi describes its method as an

improvement over the conventional method, which uses a bite impression and analyzes only contact sites, not sites where there is some separation (diastasis) between the teeth of the upper and lower jaws. *Id.* at 30-2 (§ 3.3).

We view Hayashi's teachings through the lens of applicable law. "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). On the other hand, "[a] reference does not teach away, . . . if it merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into the invention claimed." *Galderma Labs., L.P. v. Tolmar, Inc.*, 737 F.3d 731, 738 (Fed. Cir. 2013).

We are persuaded that a POSITA would have had a reason or motivation to provide an occlusion map that "only shows those distances that are less than one tenth of a millimeter," as recited in claim 12 or "only shows distances that are zero in value," as recited in claim 13, notwithstanding Hayashi's statement that, with its method of calculating interocclusal distance, "as the distance narrows, there is the possibility that the relative error for the interocclusal distance will increase." Ex. 1005, 30-2 (§ 3.2). That statement does not teach away from the claimed method for two reasons. First, the statement pertains to Hayashi's method of using the shortest distance, which is not the same as the z-axis method required by Patent Owner's claim construction for "opposite regions." PO Resp. 9, 34. As discussed above, Petitioner relies on Kunii to show Patent Owner's z-axis method. Pet. 33, 36–38. Hayashi shows the difference between the two methods. Ex. 1005, 29-2 (§ 3.2, Fig. 1).

Second, even if relevant to Petitioner's obviousness combination, Hayashi's statement does not teach away from claims 12 and 13 because it does not criticize, discredit, or otherwise discourage a POSITA from generating an occlusion map that shows only zero distances or only distances less than one tenth of a millimeter. Hayashi merely cautions that such maps may be prone to error and recommends data interpolation as a way to reduce the error. Ex. 1005, 30-2 (§ 3.2). As Petitioner points out, Kunii discloses an occlusion map that shows regions of zero distance between the teeth surfaces. Reply 19; Ex. 1003, 165-1, Fig. 3a. Kunii thus demonstrates that such an occlusion map is not only possible, but provides useful and reliable information for a dental practitioner.

We are also persuaded that a POSITA would have had a reason or motivation to provide an occlusion map that "only shows those distances that are less than one tenth of a millimeter," as recited in claim 12 or "only shows distances that are zero in value," as recited in claim 13, notwithstanding Hayashi's criticism of the conventional method of analyzing occlusion. Ex. 1005, 30-2 (§ 3.3). Hayashi identifies shortcomings of the conventional method of using a bite impression to locate contact sites. *Id.* Hayashi's criticisms do not apply to claims 12 and 13, which require obtaining an occlusion map from ***a three-dimensional virtual computer model of teeth***, not by having the patient bite down on impression material. Ex. 1001, 7:53–54, 8:48–54. Although Hayashi expresses a preference for occlusion maps that show several interocclusal distances, Hayashi does not criticize occlusion maps that show only zero distances or only distances below a threshold, such as one tenth of a millimeter. We agree with Petitioner that Hayashi Figure 4 teaches toward claims 12 and 13

by demonstrating that identification of regions of distance less than a specific value is valuable and something of interest to a POSITA. Reply 19.

Accordingly, Petitioner has shown by a preponderance of the evidence that the subject matter of claims 12 and 13 would have been obvious in view of Kunii and Hayashi.

H. Petitioner's Myszkowski-based Grounds

Petitioner contends that claims 1–3, 5, and 9–11 of the '853 Patent are anticipated by Myszkowski and that claims 12 and 13 are unpatentable as obvious in view of Myszkowski. Pet. 31–66. Patent Owner opposes. PO Resp. 48–54.

In view of our finding that Petitioner has established unpatentability of all challenged claims under the Kunii-based grounds, we do not reach Petitioner's challenges based on Myszkowski.

III. CONCLUSION

Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7, and 9–13 are unpatentable under the Kunii-based grounds alleged in the Petition.¹²

¹² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

In summary:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1–3, 5, 7, and 9–11	102(b)	Kunii	1–3, 5, 7, and 9–11	
1–3, 5, 7, and 9–11	103(a)	Kunii	1–3, 5, 7, and 9–11	
3, 5, 7, 12, and 13	103(a)	Kunii and Hayashi	3, 5, 7, 12, and 13	
1–3, 5, and 9–11	102(b)	Myszkowski		
12 and 13	103(a)	Myszkowski and Hayashi		
Overall Outcome			1–3, 5, 7, and 9–13	

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7, and 9–13 of the '853 Patent are *unpatentable*;

FURTHER ORDERED that, because this is a Final Written Decision, any party to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2019-00153
Patent 6,334,853 B1

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