

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

EXOCAD GMBH AND EXOCAD AMERICA, INC.,
Petitioner,

v.

3SHAPE A/S,
Patent Owner.

Case IPR2018-00788
Patent 9,336,336 B2

Before SALLY C. MEDLEY, IRVIN E. BRANCH, and
FRANCES L. IPPOLITO, *Administrative Patent Judges*.

BRANCH, *Administrative Patent Judge*.

JUDGEMENT

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

ORDER

Dismissing Patent Owner's Motion to Strike
Dismissing Patent Owner's Motion to Exclude Evidence
37 C.F.R. §§ 42.5, 42.64

I. INTRODUCTION

exocad GmbH, and exocad America, Inc. (“Petitioner”) filed a Petition (Paper 1, “Pet.”) requesting *inter partes* review of claims 1–30 of U.S. Patent No. 9,336,336 B2 (Ex. 1001, “the ’336 patent”). 3Shape A/S (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). On October 3, 2018, we entered our Decision on Institution (Paper 7, “Dec.” or “Decision”) instituting *inter partes* review of all challenged claims under all asserted grounds. Dec. 33.

After institution of trial, Patent Owner filed a Patent Owner Response (Paper 23, “Resp.”), Petitioner filed a Reply (Paper 26, “Reply”), and Patent Owner filed a Sur- Reply (Paper 31, “Sur-Reply”). To support its arguments, Petitioner relies on the testimony of Dr. Joseph L. Mundy (*see* Exs. 1003, 1023), while Patent Owner relies on testimony from Dr. Eli Saber (*see* Ex. 2001).

Per our authorization, Patent Owner filed a motion to strike certain arguments and evidence in petitioner’s reply. Paper 29; Paper 30 (“Mot. Strike”). Petitioner filed an opposition to Patent Owner’s motion to strike (Paper 33, “Opp. Strike”).

Additionally, Patent Owner filed a motion to exclude certain evidence in Petitioner’s reply. Paper 36 (“Mot. Exclude”). Petitioner filed an opposition to Patent Owner’s motion to exclude (Paper 37, “Opp. Exclude”) and Patent Owner filed a reply in support of the motion to exclude (Paper 38, “Reply Exclude”).

Oral argument was held on June 24, 2019 in Alexandria, Virginia, and a transcript of the hearing is included in the record. Paper 42 (“Tr.”).

We have authority under 35 U.S.C. § 6. Petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. See 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. Having reviewed the arguments of the parties and the supporting evidence, we find that Petitioner has demonstrated by a preponderance of the evidence that all challenged claims 1–30 of the ’336 patent are unpatentable. Our determination is summarized in the table at the conclusion of this decision.

A. Real Parties in Interest

Petitioner identifies the following parties as real parties in interest: exocad GmbH, exocad America, Inc., Ivory GmbH, Ivory Holding GmbH, Ivory Global Holdings GmbH, CETP III Ivory SARL (“CETP” is Carlyle

Europe Technology Partners”), CETP III Participations SARL, SICAR, and Carlyle Europe Technology Partners III, L.P. Pet. 1.¹

Patent Owner identifies only itself as a real party in interest. Paper 3.

B. Related Matters

The parties state that the ’336 patent is asserted in *3Shape A/S v. exocad GmbH, and exocad America, Inc.*, Case No. 1:17-cv-00239- ER-MPT (D. Del.). The ’336 patent was also the subject of a petition filed in IPR2018-00785. Pet. 1; Paper 3, 1. An *inter partes* review was not instituted in IPR2018-00785. *Exocad GmbH v. 3Shape A/S*, IPR2018-00785, Paper 8 (PTAB Oct. 3, 2018).

C. The ’336 Patent

The ’336 patent involves computer-implemented dental restoration design. Ex. 1001, 1:5–6 (“a method of visualizing and modeling a set of teeth for a patient”). The ’336 patent explains that dental restoration modeling combines facial imagery with a 3D model of the patient’s oral structure, to thereby allow visualization of the patient’s post-restoration appearance. *Id.* at 19:43–20:29. The 3D model is then usable for manufacturing the restoration. *Id.* at 20:26–29.

¹ Petitioner states “[n]one of the entities other than exocad GmbH and exocad America, Inc. meet the definition of a real-party-in-interest, but Petitioner nonetheless lists those additional entities as real-parties-in-interest in this matter.” Pet. 1, n. 1. Based on the complete record, we observe that there appear to be no substantive, dispositive, or procedural issues that rest on determining whether these listed entities are real-parties-in-interest.

The '336 patent acknowledges that “[v]isualization and modeling or design of teeth [were] known in the field of dental restorations” but distinguishes its method because it “may be performed faster than prior art methods.” *Id.* at 1:13–14, 3:38–39. Among the reasons given is that the '336 patent's 2D facial imagery “is not superimposed or overlaid onto the 3D virtual model for creating one representation with all data included” as is the case in the prior art, which “requires more time and exhaustive data processing.” *Id.* at 3:30–37. In particular, the '336 patent explains that at least one 2D image of the patient's facial features is arranged relative to the 3D model in 3D virtual space yet the image and the model “remain as separate data representations which are not merged or fused together into one representation.” *Id.* at 3:25–28. Figures 3A and 3B, reproduced below, are illustrative.

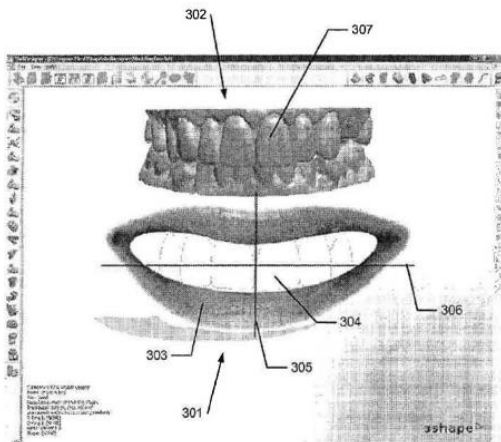


Fig. 3A

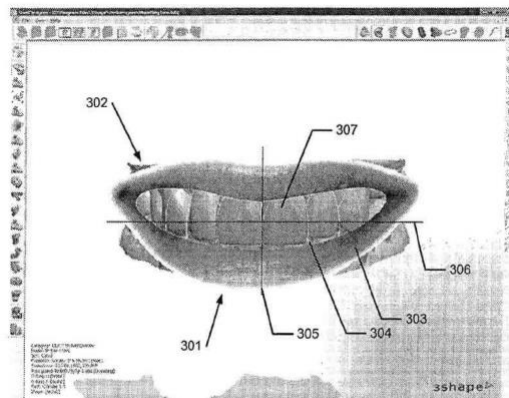


Fig. 3B

Figures 3A and 3B depict visualizing and arranging a 2D image and a 3D model. The 3D model 302 and the 2D image 301 are depicted separately in Figure 3A and depicted aligned in Figure 3B. *Id.* at 20:54–21:3. The

'336 patent explains that the teeth of the 2D image may be cut out or rendered transparent. *Id.* at Figs. 8, 11D, 11G, 11H and 23:23–35, 24:31–37, 24:60–25:3.

D. Challenged Claims

Petitioner challenges claims 1–30, which are all of the claims in the '336 patent. Of the challenged claims, claims 1 and 29 are independent. Claim 1 is reproduced below.

1. A computer-implemented method of designing a dental restoration for a patient, wherein the method comprises:
 - using a hardware processor to:
 - provide one or more 2D images, where at least one of the one or more 2D images comprises at least one facial feature, wherein the at least one facial feature comprises lips;
 - either virtually cut at least a part of teeth out of the at least one 2D image or render a part of the at least one 2D image that includes teeth at least partly or wholly transparent;
 - provide a 3D virtual model of at least part of an oral cavity of the patient;
 - arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged, whereby the 3D virtual model and the at least one 2D image are both visualized in the 3D space; and
 - design a restoration for the 3D virtual model, where the restoration is designed to fit the at least one facial feature of the at least one 2D image;

wherein the at least one 2D image and the 3D virtual model are aligned by scaling, translating or rotating the at least one 2D image or the 3D virtual model relative to each other.

Ex. 1001, 25:66–26:25.

E. Evidence and Instituted Grounds

We instituted an *inter partes* review on all of Petitioner’s requested grounds as more specifically shown below:

Ground	Claim(s)	Description ²
1	1–14, 16–20, and 22–30	Anticipated under § 102 by Wiedmann ³ (claims 1–5, 7–11, 13, 14, 16–18, 22–24, and 27–30), or Alternatively Obvious under § 103 over Wiedmann and Sachdeva ⁴ (claims 1–14, 16–20, and 22–30)
2	15	Obvious under § 103 based on Wiedmann, Sachdeva, and Lehmann ⁵
3	21	Obvious under § 103 based on Wiedmann, Sachdeva, and Seeger ⁶

² The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. §§ 102 and 103. Because the ’336 patent has an effective filing date before the effective date of the applicable AIA amendments, we refer to the pre-AIA versions of 35 U.S.C. §§ 102 and 103.

³ Wiedmann, Oliver, “According to the Laws of Harmony ... to find the right tooth shape with the assistance of the computer,” Digital Dental News, 2nd Volume, April 2008 (Ex. 1007, “Wiedmann”).

⁴ U.S. Patent No. 7,156,655 B2 to Sachdeva *et al.*, issued January 2, 2007 (Ex. 1005, “Sachdeva”).

⁵ Lehmann, Thomas M., *et al.*, “Survey: Interpolation Methods in Medical Image Processing,” IEEE Transactions on Medical Imaging, Vol. 18, No. 11, November 1999 (Ex. 1010, “Lehmann”).

⁶ U.S. Patent Publication No. US 2002/0075389 A1 to Seeger, published

Ground	Claim(s)	Description ²
4	6–8	Obvious under § 103 based on Wiedmann, Sachdeva, and MacDougald ⁷
5	1–14, 16–20, and 22–30	Anticipated under § 102 by Sachdeva, or Alternatively Obvious under § 103 over Sachdeva and Kopelman ⁸
6	15	Obvious under § 103 based on Sachdeva, Kopelman, and Lehmann
7	21	Obvious under § 103 based on Sachdeva, Kopelman, and Seeger
8	6–8	Obvious under § 103 based on Sachdeva, Kopelman, and MacDougald

II. ANALYSIS

A. Claim Construction

For petitions filed before November 13, 2018, we use the broadest reasonable interpretation in light of the specification to interpret the claims of a patent that will not expire before issuance of a final written decision. *See* 37 C.F.R. § 42.100(b) (2017)⁹; *Cuozzo Speed Techs., LLC v. Lee*, 136

June 20, 2002, (Ex. 1011, “Seeger”).

⁷ U.S. Patent No. 6,568,936 B2 to MacDougald, issued May 27, 2003 (Ex. 1009, “MacDougald”).

⁸ U.S. Patent No. 6,845,175 B2 to Kopelman *et al.*, issued January 18, 2005 (Ex. 1008, “Kopelman”).

⁹ A recent amendment to this rule does not apply here because the Petition was filed before November 13, 2018. *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) (amending 37 C.F.R. § 42.100(b) effective November 13, 2018).

S.Ct. 2131, 2144–46 (2016). Consistent with the broadest reasonable construction standard, the challenged claims are presumed to be given their ordinary and customary meaning as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). We shall construe only terms that are in controversy and then only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999); *see also Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs.* in the context of an *inter partes* review).

Petitioner proposes constructions for “2D image,” “3D virtual model of at least part of an oral cavity of the patient,” “virtual 3D space,” “remain separate representations after being arranged,” “designed to fit,” “section at least two or more teeth,” and “prepared tooth.” Pet. 7–11. Patent Owner proposes constructions for “of at least part of an oral cavity of the patient,” “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged,” and “render a part of the at least one 2D image that includes teeth at least partly or wholly transparent.” Resp. 4–8.

1. “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual

model are aligned when viewed from a viewpoint and remain separate representations after being arranged”

Petitioner contends the term “remain separate representations after being arranged” recited in independent claims 1 and 29 (required in all the challenged claims) means “the 2D image and the 3D virtual model remain in their respective formats and are not merged into a single representation.” Pet. 9; see Ex. 1001, 3:25–37 (“the 2D image and the 3D model are arranged and remain as separate data representations which are not merged or fused together into one representation”).

Patent Owner contends Petitioner’s proposed construction does not account for this term in the context of the full claim limitation, which recites “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged.” Resp. 6–7. Patent Owner argues that it is not enough to remain separate data representations but that “the 2D image and the 3D virtual model must remain separate in their respective formats ***after being arranged*** (*after* the 2D image and the 3D virtual model are aligned when viewed from a viewpoint).” *Id.* at 7. See Ex. 2001 ¶ 31.

We are persuaded Patent Owner’s proposed construction is correct. Specifically, we determine that “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged” means that the 2D image and the 3D virtual model must remain separate in their respective

formats after the 2D image and the 3D virtual model are aligned when viewed from a viewpoint. Resp. 6–7. Our construction is consistent with the express language of the claims, which recites that “2D image and the 3D virtual model are aligned when viewed from a viewpoint and *remain separate representations after being arranged*.” Emphasis added.

Our construction also is consistent with Patent Owner’s expert’s declaration testimony. Ex. 2001 ¶ 31. We find credible the testimony of Patent Owner’s expert, Dr. Saber, who testifies that

[b]y reciting “such that”, the “arrange” limitation requires an arrangement of the 2D image and the 3D virtual model in which both: (1) the 2D image and the 3D virtual model are aligned when viewed from a viewpoint and (2) the 2D image and the 3D virtual model remain separate representations after being arranged, i.e., in the aligned state.

Ex. 2001 ¶ 31. This testimony takes into account the express language of the claim, which we agree must be considered in construing this limitation.

In its Sur-reply, Patent Owner argues also that the construction of this term precludes the merging or fusing of the 2D image and the 3D virtual model after alignment. Sur-reply 3; Tr. 40: 3–6 (“MR. LEE: It remains [two representations] for all time. That’s the natural read of the claim, . . . [that] the claims require that the 2D image and 3D virtual model remain separate representations after being arranged.”). We understand Patent Owner’s position to be that the 2D image and 3D virtual model must remain separate indefinitely after being aligned when viewed from a viewpoint. *Id.*; Tr. 41: 4–9 (“MR. LEE: It is indefinite. As Your Honor – as you said, it is indefinite . . . the claims require that the 2D image and 3D virtual model

remain separate representations after being arranged.”). However, the express language of the claim does not dictate any temporal limit or duration is required for how long the 2D image and the 3D virtual model must remain separate representations after being arranged. Further, the Specification teaches that it is an advantage to keep the 2D image and the 3D model separate, by not merging or fusing the two into a single representation. Ex. 1001, 3:25–31. Nonetheless, even here, the Specification does not go so far as requiring that the 2D image and the 3D model remain separate indefinitely. In fact, no temporal limit or requirement is described in the ’336 patent. Certainly, the ’336 patent does not describe the separation as indefinite. Thus, we are not persuaded that “remain separate representations after being arranged” requires that the data representations remain separate indefinitely after being arranged. Similarly, we are not persuaded that “remain separate representations after being arranged” precludes momentarily remaining separate data representations after being arranged. In short, our construction does not place a temporal limitation on how long the 2D image and the 3D virtual model remain separate. Again, this construction is consistent with both the Specification (Ex. 1001, 3:25–37) and the language of the claims (*id.* at 26:12–18, 28:28–34), neither of which specify a minimum (or any specific) length of time that the 2D image and the 3D virtual model must remain separate data representations after being arranged.

2. Other Terms

We do not find it necessary to construe any other terms explicitly. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).

B. Principles of Law

1. Anticipation

“A claim is anticipated 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. Inc. v. Union Oil Co.*, 814 F.2d 628, 631 (Fed. Cir. 1987). Moreover, “[b]ecause the hallmark of anticipation is prior invention, the prior art reference—in order to anticipate under 35 U.S.C. § 102—must not only disclose all elements of the claim within the four corners of the document, but must also disclose those elements ‘arranged as in the claim.’” *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008). Whether a reference anticipates is assessed from the perspective of an ordinarily skilled artisan. *See Dayco Prods., Inc. v. Total Containment, Inc.*, 329 F.3d 1358, 1368 (Fed. Cir. 2003) (“‘[T]he dispositive question regarding anticipation [i]s whether *one skilled in the art* would reasonably understand or infer from the [prior art reference’s] teaching’ that every claim element was disclosed in that single reference.”).

2. Obviousness

In *Graham v. John Deere Co.*, 383 U.S. 1 (1966), the Supreme Court set out a framework for assessing obviousness under § 103 that requires consideration of four factors: (1) the “level of ordinary skill in the pertinent art,” (2) the “scope and content of the prior art,” (3) the “differences between the prior art and the claims at issue,” and (4) “secondary considerations” of non-obviousness such as “commercial success, long-felt but unsolved needs, failure of others, etc.” *Id.* at 17. “While the sequence of these questions might be reordered in any particular case,” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 407 (2007), the Federal Circuit has “repeatedly emphasized that an obviousness inquiry requires examination of all four *Graham* factors and that an obviousness determination can be made only after consideration of each factor.” *Nike, Inc. v. Adidas AG*, 812 F.3d 1326, 1335 (Fed. Cir. 2016).

We note that, with respect to the fourth *Graham* factor, the record does not include any argument or evidence directed to secondary considerations of nonobviousness. Therefore, the analysis below addresses the first three *Graham* factors.

C. The Level of Ordinary Skill

In determining the level of skill in the art, we consider the type of problems encountered in the art, the prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level of active workers in the field. *Custom*

Accessories, Inc. v. Jeffrey-Allan Indus. Inc., 807 F.2d 955, 962 (Fed. Cir. 1986); *Orthopedic Equip. Co. v. U.S.*, 702 F.2d 1005, 1011 (Fed. Cir. 1983).

Petitioner relies on the testimony of Dr. Joseph L. Mundy, who testifies as follows:

a person of ordinary skill in the art of software systems, including digital dental systems, is generally one who has a Bachelor's degree in electrical engineering or computer science, or it could be someone in a related discipline who also has a few years of relevant academic, research or industry work experience. Such a person would also typically have the ability to learn information about the needs of the users of dental design software (e.g., dentists, dental lab clinicians, etc.), including such information coming from others who have interacted or worked with such users of dental design software or have relevant experience in the dental design software industry. Often software is developed in teams, with not every individual on the team being a computer programmer.

Ex. 1002 ¶ 48; *see id.* ¶¶ 47–54; Pet. 7.

Patent Owner relies on the testimony of Dr. Saber, who testifies similarly. *See* Ex. 2001 ¶ 26, Resp. 4. Specifically, Patent Owner asserts that

[a] person of ordinary skill in the art (“POSITA”) would have a bachelor's degree in electrical engineering, computer engineering, computer science, or an equivalent field, as well as at least one or two years of industry or research experience with computer vision/graphics making use of three-dimensional virtual models. Such a person would also typically have the ability to learn information about the needs of the users of dental or biomedical design software.

Resp. 4.

We determine that no material dispute exists over the level of ordinary skill, and the record prior art references support Petitioner's proposed level of ordinary skill. Based on the evidence of record, including the types of problems and solutions described in the '336 patent and the asserted prior art, we agree with and adopt Petitioner's definition of the level of ordinary skill in the art. Further, we would reach the same findings and determinations under either party's definition of the level of ordinary skill in the art.

D. Anticipation Challenge Based on Sachdeva

Petitioner asserts that Sachdeva anticipates claims 1–14, 16–20, and 22–30. Pet. 16–48, 55–79.¹⁰ Patent Owner contends that Sachdeva does not anticipate these claims because it does not describe “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged” and “either virtually cut[ting] at least a part of teeth out of the at least one 2D image or render[ing] a part of the at least one 2D image that includes teeth at least partly or wholly transparent,” as recited in independent claims 1 and 29. Resp. 28–47. Patent Owner disputes that Sachdeva anticipates the

¹⁰ Petitioner's mapping of the claims to Sachdeva in the claim charts of pages 55–79 of the Petition do not specifically refer to Sachdeva but rather refer to the claim chart Petitioner provides for mapping the claims to the combination of Wiedmann and Sachdeva at pages 16–48. Our analysis references the claim chart mapping the claims to the combination of Wiedmann and Sachdeva to avoid confusion.

dependent claims for the same reasons. *Id.* at 46. For claim 6, which recites “the first 3D virtual model comprises at least one prepared tooth,” Patent Owner argues that “Sachdeva has no mention of prepared teeth.” *Id.* at 46. Patent Owner argues claims 7 and 8 on the additional basis that they depend from claim 6. *Id.* at 47. For claim 9, which recites “the hardware processor is used to virtually cut at least a part of teeth out of the at least one 2D image,” Patent Owner relies on the same arguments provided for claim 1. *Id.* For the remaining challenged claims 2–5, 10–14, 16–20, and 22–28, and 30, Patent Owner does not present any arguments separate from those discussed above. *See generally* Resp.

1. Sachdeva (Ex. 1005)

Sachdeva describes “[a] method and workstation for evaluation of an orthodontic treatment plan for a patient.” Ex. 1005, Abst. It describes using two data sets, one of which may be 2D images of the patient’s face and head, and the other may be 3D image information of the patient’s teeth. *Id.* at 6:46–50. The first data set is used to create a model of the patient’s face, which is aligned in virtual 3D space with a 3D tooth model based on the second data set. *Id.* at 6:14–7:44. This arrangement is then used to design a dental restoration for the patient. *Id.* at 7:45–57. The arrangement is depicted in Figure 6, reproduced below.

FIG. 6

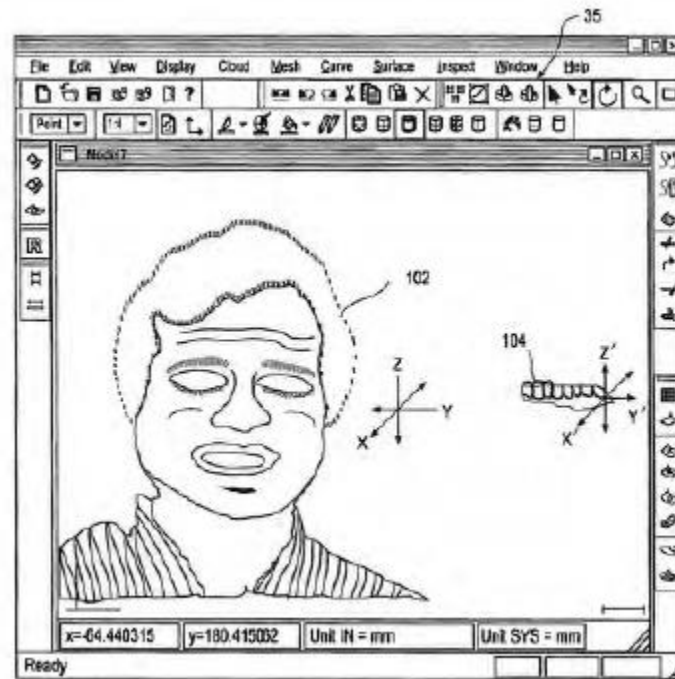


Figure 6 depicts a 3D virtual environment in which a “3D morphable model” 102 of the patient’s face is shown in one coordinate system on the left side of the display and a 3D model of the patient’s teeth is shown in a 3D coordinate system on the right side of the screen. *Id.* at 14:26–31. Icons 35 “allow the user to position the tooth model 104 relative to the morphable model 102 in order to combine the two in a common coordinate system and construct a composite model.” *Id.* Tools allow the user to “hide one or more image data in order to study certain features.” *Id.* at 15:26–27; *see id.* at 30:8–12 (“[t]he screen display 622 includes a plurality of icons 624 which are used for hiding and displaying various aspects of the virtual patient model, soft tissue, occlusal planes, and other features of the software.”).

2. Analysis

Petitioner provides detailed claim charts mapping the elements of claims 1–14, 16–20, and 22–30 to the teachings of Sachdeva, and refers to supporting testimony by Dr. Mundy. Pet. 16–48; *see* Ex. 1002 ¶¶ 466–570.

Patent Owner disputes Petitioner’s case. A central thesis of Patent Owner’s arguments is that the “’336 Patent distinguishes its technique from prior art techniques in which the 2D image and 3D model are merged or combined into one composite representation.” Resp. 3; Ex. 2001 ¶ 28 (citing Ex. 1001, 3:25–37) (“By keeping the data representations as separate representations, time is saved and data processing time and capacity is reduced. Thus the 2D image is not superimposed or overlaid onto the 3D virtual model for creating one representation with all data included.”); *see* Resp. 34–36 (“Unlike the claimed approach of visualizing ‘separate representations’ in an aligned state, Sachdeva employs the conventional approach of merging the images into one representation with all data included. Ex. 2001 at ¶ 68.”).

Having framed Petitioner’s and Patent Owner’s arguments broadly, we now turn to the specific contentions of Petitioner and Patent Owner with respect to anticipation by Sachdeva.

(a) Claims 1 and 29

- i. “[a] computer-implemented method of designing a dental restoration for a patient . . . provid[ing] one or more 2D images, where at least one of the one or more 2D images comprises at least one facial feature, wherein the at least one

facial feature comprises lips . . . provid[ing] a 3D virtual model of at least part of an oral cavity of the patient”

Claim 1 is generally directed to “[a] computer-implemented method of designing a dental restoration for a patient” and includes using a hardware processor to perform the method. Ex. 1001, 25:66–26:25. Claim 29 recites a system having a hardware processor configured to perform method steps that are similar to those of claim 1. *Id.* at 28:15–41. Below, we discuss claim 1, which is representative of independent claim 29.

Claim 1 also recites “provid[ing] one or more 2D images, where at least one of the one or more 2D images comprises at least one facial feature, wherein the at least one facial feature comprises lips” and “provid[ing] a 3D virtual model of at least part of an oral cavity of the patient.”

Petitioner maps these limitations to, *inter alia*, Sachdeva’s description that it “relates to the field of computerized techniques for orthodontic treatment planning of human patients” (Ex. 1005, 1:18–20) and that its system “includes a general-purpose computer system having a processor” (*id.* at 6:25–26). Petitioner argues that Sachdeva describes that the system includes memory that “stores two or more sets of digital data representing patient craniofacial image information.” Pet. 16–25. According to Petitioner, Sachdeva describes “a representative and non-limiting example of the data sets, [wherein] the first data set 24 could be a set of two dimensional color photographs of the face and head of the patient . . . and the second data set is three-dimensional image information of the patient’s teeth” (*id.* at 6:45–50), which Petitioner references for the foregoing limitations. Pet. 23–

25. Petitioner's contentions are supported by the testimony of Dr. Mundy. Pet. 16–20, 23–25 (citing Ex. 1002 ¶¶ 298, 300, 302–07, 310, 311, 319–22).

Patent Owner does not dispute that Sachdeva describes these limitations. *See generally* Resp. 28–46; Sur-Reply 5–20. Rather, Patent Owner contends generally that Sachdeva's 2D images are transformed into a 3D model for further operations. Resp. 32; Sur-Reply 5–7 (citing Ex. 2001 ¶¶ 62–67). Patent Owner presents three main arguments for this position. First, Patent Owner contends that Sachdeva explicitly discloses that in Figure 6, the display shows a 3D morphable model 102 of the patient. Resp. 29 (citing Ex. 1005, 7:11–14, 7:38–39, 7:47–48, 7:55–56, 13:15–16, 14:15–17; Ex. 2001 ¶ 62). Second, Patent Owner argues that Sachdeva's 2D color pictures of the face are taken and converted automatically to a textured 3D model. Resp. 30 (citing Ex. 1005, 11:4–7, 14:18–20; Ex. 2001 ¶ 63). Third, Patent Owner asserts that “Blan[t]z et al., A Morphable Model for The Synthesis of 3D Faces, Computer Graphics Proceedings SIGGRAPH '99 (August 1999) (Ex. 2003 (“Blantz”))” shows that the term “morphable model” in Sachdeva refers to a 3D morphing function or a 3D model formed by a morphing function. Resp. 30 (citing Ex. 2003, 1; Ex. 2001 ¶ 64). Although Patent Owner acknowledges that Sachdeva describes “the use of ‘a set of two dimensional color photographs of the face and head of the patient’” (Resp. 32 (quoting Ex. 1005, 6:45–48)), Patent Owner argues that “Sachdeva further discloses that the set of 2D color face photographs ‘are combined in the computer to form a 3D morphable face model’” (*id.* (quoting Ex. 1005, 7:29–35)) and that “[i]t is this 3D morphable face model,

not the set of 2D color face photographs, that is combined with a 3D teeth model to form the virtual patient model” (*id.* (citing Ex. 1005, 14:28–32)).

Patent Owner’s expert, Dr. Saber, testifies that “[t]he one or more image data that can be hidden is of the virtual model, i.e., the result of the combination of various image data, not of a 2D image purportedly used to prepare the virtual model.” Ex. 2001 ¶ 77. Thus, Patent Owner contends that the “virtual patient model” from which one or more image data may be hidden is 3D and is not the 2D images provided in the preceding limitation. Resp. 43.

We are not persuaded Patent Owner’s narrow reading of Sachdeva is correct—that the “virtual patient model” from which one or more image data may be hidden is 3D and is not the 2D images provided in the preceding limitation. Resp. 43. We refer to Figure 7, which is reproduced below with color annotations added by Petitioner:

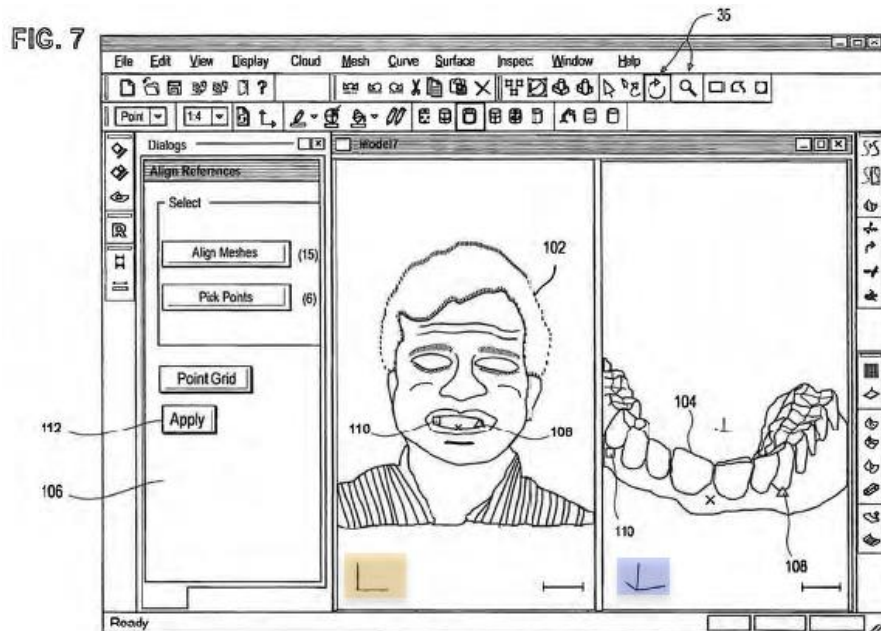


Figure 7 depicts a screen display which appears upon a user's selection of the "Align References" icon. Ex. 1005, 14:33–34. Selection of the icon "causes the screen display to show the box 106 on the left hand side of the screen[, and t]he user is provided with the option to pick points that represent anatomical structures that are common to both the morphable model 102 and the 3D tooth model 104." *Id.* at 14:34–38. Here, the "morphable face model 102" is depicted in a 2D coordinate system in the left window (as indicated by the yellow highlighted coordinates), in contrast to the right window in which the "3D tooth model 104" is depicted in a 3D coordinate system (blue highlighting). "The user then clicks on the 'Apply' tab 112[, and t]he result is the 3D tooth model 104 is combined with the morphable face 102 model to produce a combined virtual patient model." *Id.* at Fig. 7; 14:35–45.

With respect to the dimensionality of various data sets and a broader understanding of Sachdeva, Sachdeva describes a workstation that, in a preferred embodiment, "provides software features that create two dimensional and/or three-dimensional virtual patient model on a computer." Ex. 1005, 5:64–66. Sachdeva also describes a "representative and non-limiting example" of operating on data sets that include both two-dimensional and three-dimensional image information acquired from a variety of sources. Ex. 1005, 6:45–61.

Further, we note that Petitioner's expert, Dr. Mundy, testifies a POSITA reading Sachdeva as a whole would understand that Sachdeva describes a workstation that operates interchangeably on data sets of either

two or three dimensions, particularly with respect to references to a “morphable model.” Ex. 1002 ¶ 304. *See id.* at 302–04, 306; Ex. 1005, Fig. 1 (camera 28 and also other image devices 36, such as an x-ray, providing image data 24, 26 and 27), Fig. 19 (“2D scanning devices”), 6:45–47 (“the first data set 24 could be a set of two dimensional color photographs of the face and head of the patient obtained via a color digital camera 28”), 6:48–50 (“the second data set is three-dimensional image information of the patient’s teeth, acquired via a suitable scanner 30”), 6:51–54 (“other sets 27 of digital image data, including digitized X-Rays . . .”), 19:56–60 (“two dimensional images, such as a color digital camera or X-Ray machine”). Dr. Mundy states that “[a]lthough Sachdeva often refers to the morphable model 102 as ‘3D,’” the fact that “the ‘morphable model’ is often referred to without specifying it as being ‘3D’ “demonstrates the ‘morphable model 102’ is not limited to being 3D.” *Id.*

In view of the foregoing disclosure of Sachdeva, we are not persuaded by Patent Owner that Sachdeva precludes using 2D images and a 3D virtual model for the alignment process because Sachdeva discloses combining 2D color face photographs to form a 3D morphable face model that is then combined with a 3D teeth model to form the virtual patient model. *See, e.g.,* Resp. 32. Although Sachdeva discloses exemplary embodiments in which 2D color face photographs are used to form a 3D morphable face model that is then combined with a 3D teeth model (*see, e.g.,* Ex. 1005, 11:4–7), these additional teachings do not negate Sachdeva’s broader express disclosure, namely that a “preferred embodiment” of Sachdeva’s workstation “provides

software features that create two dimensional and/or three-dimensional virtual patient model on a computer, which can be used for purposes of treatment planning.” *Id.* at 5:63–66.

Regarding Blantz, Patent Owner contends “Blan[t]z discloses that ‘[t]he morphable face model is a multidimensional **3D** morphing function that is based on the linear combination of a large number of **3D face scans**.’” Pet. 30 (citing Ex.2003 at 1 with emphasis). Patent Owner argues that “Blan[t]z’s description of a morphable model (which is incorporated by reference by Sachdeva) is further evidence that the term ‘morphable model’ as used in Sachdeva refers to a 3D morphing function or a 3D model formed from such morphing function—not a 2D image.” *Id.* (citing Ex. 2001 ¶64).

Sachdeva incorporates Blantz by reference. *See* Ex. 1005, 2:28–40. To whatever extent Blantz excludes the morphable model from being 2D, we do not find Blantz to be limiting with respect to Sachdeva’s broader disclosure of a workstation that “provides software features that create two dimensional and/or three-dimensional virtual patient model on a computer, which can be used for purposes of treatment planning.” *Id.* at 5:63–66. Sachdeva makes clear that Blantz’s techniques for creating a 3D morphable model are merely exemplary or “alternative embodiments.” *See, e.g., id.* at 12:40–61 (“While the above discussion has described how 3D image of the face can be obtained from a three-dimensional scanner, there are other possibilities that may be used in the practice of alternative embodiments . . . known and described in . . . Blantz.”); 12:3–21 (“There are two possible approaches for creating the 3D face, one using a color digital camera 28

(FIG. 1) and another using scanning of the face using the hand held scanner 30 and scanning node 31 (FIG. 1), as one possible example. Other types of scanning or imaging techniques can be used . . . using the techniques known in the art and described in . . . Blantz.”). Thus, because Sachdeva’s incorporation of Blantz is exemplary, and therefore non-limiting, we do not give significant weight to the fact that Sachdeva incorporates Blantz by reference.

Accordingly, Petitioner’s position with respect to the 2D images and 3D model limitations is persuasive. Consistent with Petitioner’s contentions, we find Sachdeva describes “an interactive workstation” for “planning treatment for orthodontic patients.” Ex. 1005, 5:20–23. Because a face includes lips and because teeth are part of the oral cavity, claim 1’s “provid[ing] 2D images compris[ing] . . . lips [and] a 3D virtual model of at least part of an oral cavity of the patient” is taught by Sachdeva’s express disclosure of “a set of two dimensional color photographs of the face and head of the patient . . . and the second data set is three-dimensional image information of the patient’s teeth.” *Id.* at 6:45–50. We thus find Sachdeva describes these limitations.

ii. *“either virtually cut at least a part of teeth out of the at least one 2D image or render a part of the at least one 2D image that includes teeth at least partly or wholly transparent”*

Claim 1 also recites “either virtually cut at least a part of teeth out of the at least one 2D image or render a part of the at least one 2D image that includes teeth at least partly or wholly transparent.” Thus, the claim requires

only one of: 1) virtually cutting teeth from the image; or 2) rendering the teeth some degree of transparent.

Petitioner contends Sachdeva describes this limitation in multiple locations. Pet. 21–23 (citing Ex. 1005, Figs. 6, 8, 9; 14:53–67, 15:1–27, 30:8–12); Ex. 1002 ¶¶ 313–317. In particular, Petitioner argues Sachdeva describes “render a part of the at least one 2D image that includes teeth at least partly or wholly transparent” because Sachdeva teaches “the user is provided with tools that allow the user to hide one or more image data in order to study certain features” (Ex. 1005, 15:25–27) and “[t]he screen display 622 includes a plurality of icons 624 which are used for hiding and displaying various aspects of the virtual patient model, soft tissue, occlusal planes, and other features of the software” (*id.* at 30:8–12). Pet. 22. Regarding Figure 6, Petitioner contends that “Figure 6 illustrates an image of the patient where the patient’s teeth have been cut out.” Pet. 21. Further, Dr. Mundy testifies regarding Sachdeva’s disclosure of “a plurality of icons 624 which are used for hiding and displaying various aspects of the virtual patient model, soft tissue, occlusal planes, and other features of the software,” that “[b]y referring broadly to ‘other features,’ a POSITA would understand that the task is not limited to hiding features on the virtual patient model and not excluding those features from being teeth.” Ex. 1023 ¶ 38; Ex. 1005, 30:8–12.

Patent Owner argues that Sachdeva does not describe “either virtually cut at least a part of teeth out of the at least one 2D image or render a part of the at least one 2D image that includes teeth at least partly or wholly

transparent.” Resp. 42–46 (citing Ex. 2001 ¶ 76–79); Sur-Reply 17–20. Patent Owner first argues that Sachdeva explicitly discloses that the morphable face model in Figure 6 includes teeth. Resp. 42–43. This argument relies on Sachdeva’s disclosure with reference to Figure 6 that “the data representing the morphable face model indicates that the spatial dimensions of the teeth in the morphable face model is substantially the same as the spatial dimensions of the virtual tooth model 104.” *Id.* at 43 (quoting with emphasis Ex. 1005, 14:46–52).

We determine Patent Owner’s argument unpersuasive because the passage on which Patent Owner relies does not refer to the teeth directly but rather to the “spatial dimensions of the teeth.” Ex. 1005, 14:46–52.

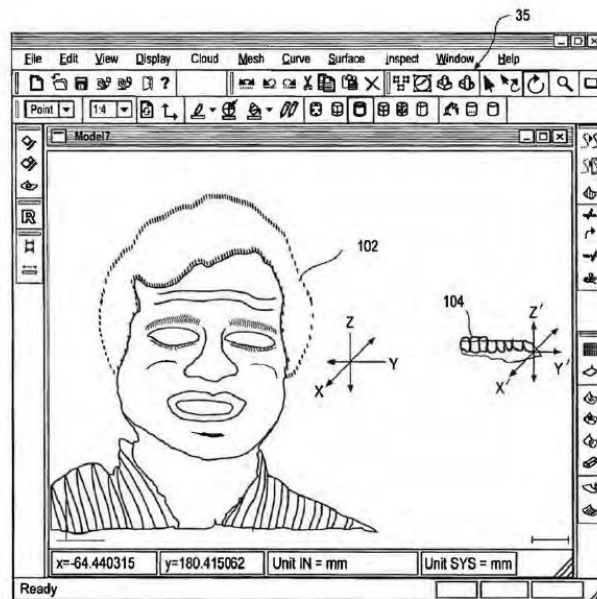
Specifically, Sachdeva discloses

In the example of FIGS. 6–7, the morphable model 102 was already scaled to the same scale as the tooth model 104. In other words, the data representing the morphable face model indicates that the spatial dimensions of the teeth in the morphable face model is substantially the same as the spatial dimensions of the virtual tooth model 104. Methods of performing scaling are described below.

Id. Thus, we do not agree that Sachdeva “explicitly” discloses that Figure 6 includes teeth by virtue of disclosing that the spatial dimensions of the teeth in the morphable face model are substantially the same as the spatial dimensions of the teeth. *Id.* This is not the same as disclosing the morphable model shows teeth. Moreover, Patent Owner and Dr. Saber acknowledge that Sachdeva’s Figure 6 does not depict certain details such as the teeth and eyes of the patient. See Ex. 2001 ¶ 76 (“[W]hile Fig. 6 itself

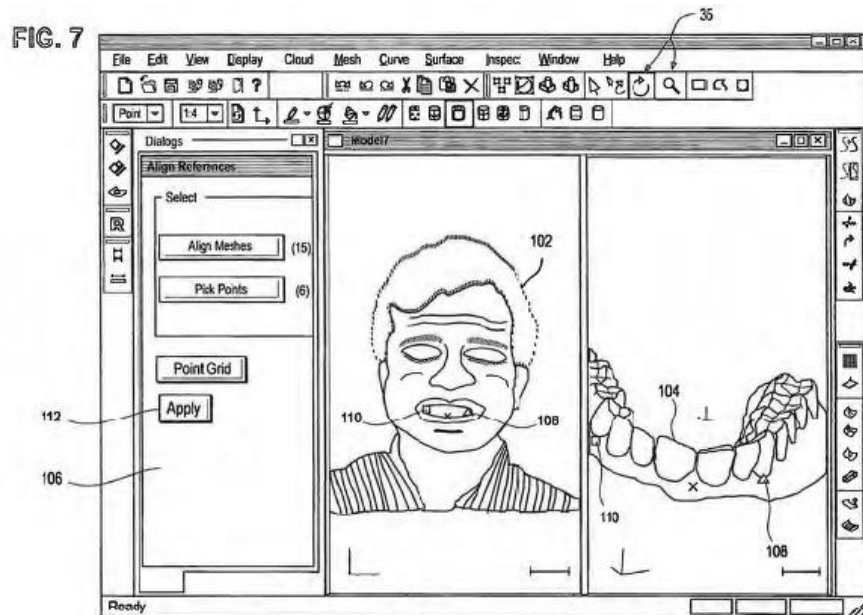
may not depict certain details such as the teeth and eyes of the patient, the description of Sachdeva unequivocally discloses that the morphable face model includes teeth.”); *see also* Ex. 1026, 143:21–25, 144:4–10. Indeed, from our review, Figure 6 clearly depicts a morphable model without any teeth; i.e., the teeth have been removed from the image. For convenience, Figure 6 is shown below:

FIG. 6



As shown in Figure 6, the morphable model 102 does not contain teeth. We find no persuasive evidence that the person depicted in Figure 6 was toothless to begin with, so figure 6 depicts teeth having been removed, i.e., the teeth having been “virtually cut . . . out of the at least one 2D image.”

Likewise, Figure 7 does not show any teeth, which is consistent with Petitioner’s position—and our determination with respect to Figure 6—that Sachdeva discloses that the teeth are removed or not shown in the morphable model. Figure 7 is reproduced below.



As previously discussed, Figure 7 depicts a screen display which appears upon a user's selection of the "Align References" icon. Ex. 1005, 14:33–34. As we discussed above, Figure 7 depicts a 2D image 102. Because the teeth are missing, Figure 7 also depicts teeth having been removed, i.e., the teeth having been "virtually cut . . . out of the at least one 2D image."

Patent Owner next argues that Petitioner does not even allege that a part of the X-ray image that includes the teeth in Sachdeva is partly or wholly transparent. Resp. 44. Patent Owner contends "[t]here is no indication that the lips in Fig. 9 of Sachdeva are obtained from the X-ray data 116." *Id.* Patent Owner also argues that the "virtually cut/render transparent" limitation requires an active step of causing a part of the 2D image to become partly or wholly transparent. *Id.* at 45–46. These arguments do not persuasively rebut Dr. Mundy's testimony (Ex. 1023 ¶ 38)

that Sachdeva's tools "for hiding and displaying various aspects of the virtual patient model, soft tissue, occlusal planes, and other features of the software" (Ex. 1005, 30:8–12) describe tools usable to "virtually cut at least a part of teeth out of the at least one 2D image." Dr. Mundy's testimony here does not refer to Figure 9, which Patent Owner argues, and the tools Dr. Mundy refers to for "hiding" disclose an "active step" that Patent Owner contends is otherwise missing from Sachdeva's disclosure.

Accordingly, we are persuaded that Sachdeva describes "either virtually cut at least a part of teeth out of the at least one 2D image or render a part of the at least one 2D image that includes teeth at least partly or wholly transparent."

iii. "arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space . . . , whereby the 3D virtual model and the at least one 2D image are both visualized in the 3D space"

Claim 1 also recites "arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space . . . , whereby the 3D virtual model and the at least one 2D image are both visualized in the 3D space."

Petitioner contends that Sachdeva describes this at various locations. See Pet. 25–28, 31 (citing Ex. 1005, Figs. 5A, 6, 28; 13:41–40, 14:14–45, 25:28–45, 28:59–29:31). Petitioner's contentions are supported by the testimony of Dr. Mundy. Ex. 1002 ¶¶ 323–29, 39–40. In particular, the Petition reproduces Figure 6 of Sachdeva as depicted below.

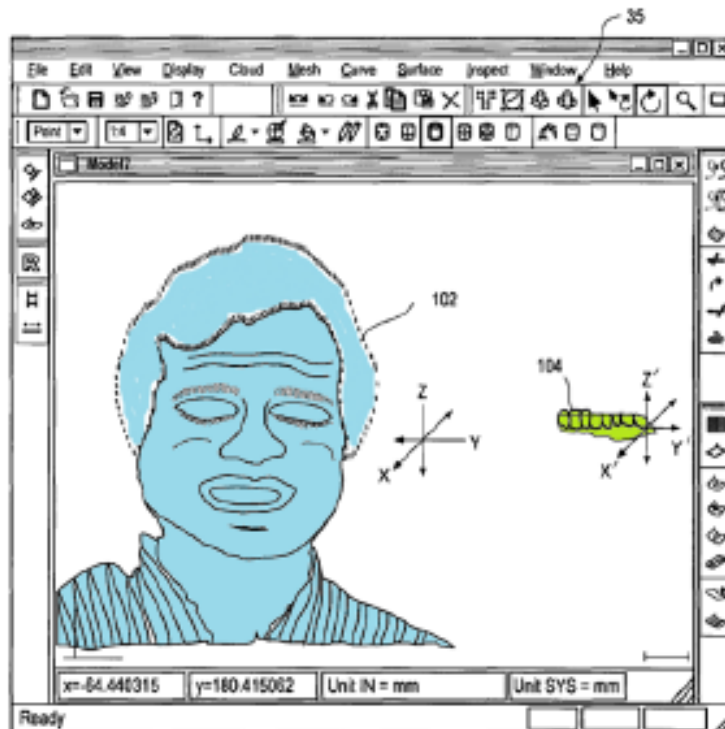


Figure 6, as reproduced in the Petition, shows the “morphable model 102” (highlighted in blue) and the 3D model “three-dimensional model 104” (highlighted in green) arranged in a virtual 3D space. Pet. 26–27 (citing Ex. 1005, Fig. 6; 14:14–45). Petitioner contends that the depicted “morphable 102” is “a 2D image.” *Id.*; see Ex. 1002 ¶ 326.

Patent Owner does not present any arguments specific to this limitation, but argues generally that the morphable model 102 in Figure 6 is 3D and not 2D. Resp. 29–34. These arguments have been addressed above. For the same reasons discussed, Patent Owner’s arguments do not persuade us that Sachdeva’s morphable face model is precluded from being 2D. As we explained above, we do not find persuasive that “Sachdeva . . . never describes the morphable model 102 as being 2D” (Resp. 30) in view of

Figure 7 and Dr. Mundy's testimony that a POSITA reading Sachdeva as a whole would have understood that Sachdeva describes a workstation that operates interchangeably on data sets of either two or three dimensions, particularly with respect to references to a "morphable model." Ex. 1002

¶ 304. Dr. Mundy's testimony is consistent with Sachdeva's description of a workstation that, in a preferred embodiment, "provides software features that create two dimensional and/or three-dimensional virtual patient model on a computer" (Ex. 1005, 5:64–66) and a "representative and non-limiting example" of operating on data sets that include both two-dimensional and three-dimensional image information acquired from a variety of sources (Ex. 1005, 6:45–61).

As to Patent Owner's arguments that "Sachdeva discloses that the morphable model is **obtained from** 2D color pictures, not that the morphable model itself is a 2D picture" and that Blantz is evidence that the morphable model is always 3D (Resp. 30), we are not persuaded. Instead, we give substantial weight to Dr. Mundy's testimony that the portions of Sachdeva that Patent Owner cites are exemplary embodiments. *See, e.g.*, Ex. 1005, 11:4–7 ("Basically, in this alternative, two-dimensional color pictures of the face are taken which are converted automatically to a textured 3 dimensional model using a 'morphable model' technique."); 14:18–20 ("The morphable model 102 is obtained, for example, from color photographs using the techniques described previously"). These exemplary embodiments do not limit Sachdeva's broader disclosure of a "representative and non-limiting

example” of operating on data sets that include both two-dimensional and three-dimensional image information. Ex. 1023 ¶¶ 12–13, 17–19.

Thus, we are persuaded that Sachdeva describes “arrang[ing] the at least one 2D image relative to the 3D virtual model in a virtual 3D space . . . , whereby the 3D virtual model and the at least one 2D image are both visualized in the 3D space.” We are persuaded at least because Figure 6 depicts an embodiment of “a 3D morphable model 102 of patient on the left hand side of the display, in a given arbitrary coordinate system X, Y, Z . . . and “[a] three-dimensional model 104 of teeth of the patient . . . on the right hand side of the screen” (Ex. 1005, 14:14–21) and because the “3D morphable model 102” of Figure 6 is exemplary of Sachdeva’s broader disclosure of operating on data sets that include both two-dimensional and three-dimensional image information (Ex. 1005, 6:45–61).

iv. *“such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged”*

Claim 1 recites that the 2D image and 3D virtual model are arranged “such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged.” The Petition contends that the alignment feature is disclosed by Sachdeva at various locations. See Pet. 28–31 (citing Ex. 1005, Fig. 7 (“Align References”); 4:57–60 (“FIG. 7 is a screen shot showing one possible method of placement of the lower jaw 30 data into the face data coordinate system using corresponding points that are common to each data set.”); 14:28–52 (“[A]llow the user to position the tooth model 104 relative

to the morphable model 102 in order to combine the two in a common coordinate system”); *see also* Ex. 1005, 11:51–15:39, 13:2–4 (“performs an aligning transformation on the data sets from each of these modules”); 15:10–14, 43:52–55 (describing “[t]he ability to superimpose Xray or other images on the proposed set-up; [t]he ability to compare the proposed set-up against a variety of image data, including photographs”); 47:58–48:26 (“[T]he panorex Xray is available and can be overlaid on the 3D tooth model. . . . [V]iews are provided to the user in checking the alignment”); Figs. 28–31, 28:59–29:63 (“[A]lign two dimensional images of the patient, e.g. x-rays, with three-dimensional virtual teeth models. . . .”). Petitioner’s contentions are supported by the testimony of Dr. Mundy. *See* Ex. 1002 ¶¶ 330-35.

As to the “remain separate representations after being arranged” feature, the Petition cites various locations of Sachdeva. Petitioner contends that

Sachdeva teaches that the face image/model and 3D tooth model remain separate representations. This includes the “morphable model 102” of the face remaining a separate representation from the 3D tooth model 104, as shown in Figure 6 (above), which shows the “morphable [face] model 102” and the separate 3D tooth model 102 aligned and visualized together, but able to be moved separately.

Pet. 30 (citing Ex. 1005, 14:27–32 (“**allow the user to position** the tooth model 104 relative to the morphable model 102”); Ex. 1005, 25:28–45 (“[t]he images can be combined or **superimposed**”); 9:40–48 (“the ability to toggle back and forth between these views . . .”).

Petitioner further contends that “Sachdeva explicitly describes how the 2D image can be pulled up later, after the 2D image and 3D model were arranged.” *Id.* at 30–31 (citing Ex. 1005 Fig. 67 (showing 2D images of “Facial: Frontal,” “Facial: Profile,” and “Facial: Smile”)); 45:60–62 (“recalls from memory photographic image data for the patient”). Petitioner’s contentions are supported by the testimony of Dr. Mundy. Ex. 1002 ¶¶ 336–38.

As discussed above, Patent Owner contends Sachdeva’s references to combining a “morphable model” with a three-dimensional model of teeth refer to a 3D morphable model, not a 2D image, and “Sachdeva discloses that the morphable model is **obtained from** 2D color pictures, not that the morphable model itself is a 2D picture.” Resp. 29–34.

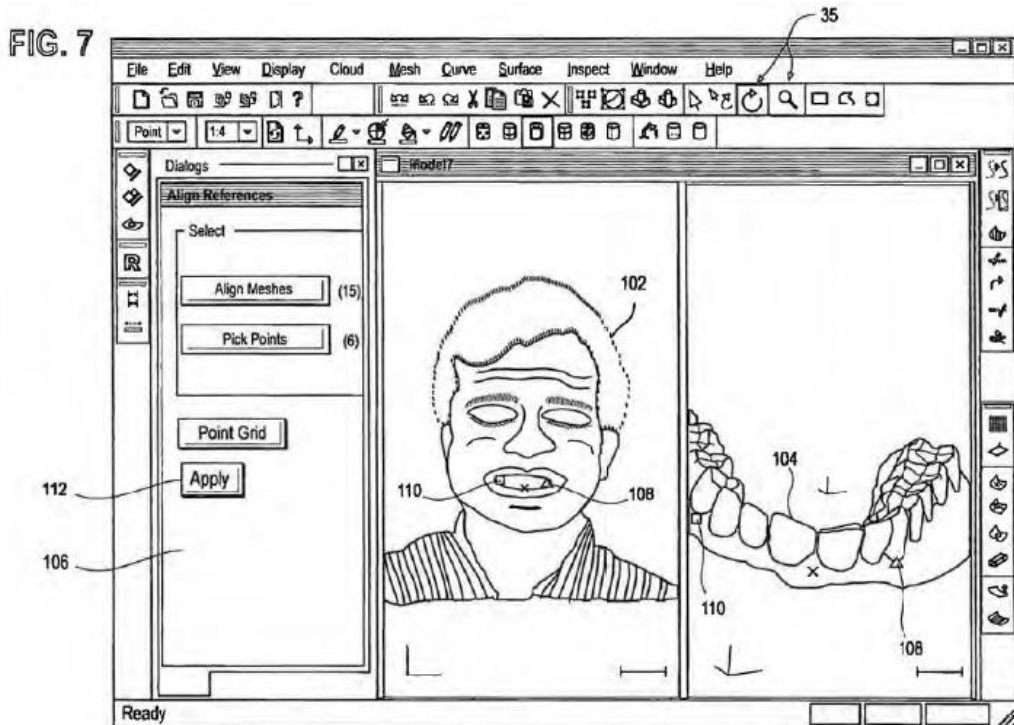
Patent Owner also argues that, “[e]ven if Sachdeva discloses that the virtual patient model may be two dimensional, Sachdeva does not disclose combining a 2D morphable model with a 3D teeth model to result in such a 2D virtual patient model.” Resp. 31. Patent Owner contends that “Petitioner’s own evidence suggests that, in the case where a **2D** virtual patient model is created, such 2D virtual patient model is created utilizing a **2D** data set with another **2D** data set—not 3D data.” *Id.*

Petitioner’s “evidence” to which Patent Owner refers is a patent “which shares most of the same specification” as Sachdeva, the ’937 patent (Ex. 1013).¹¹ See Pet. 19. Petitioner raised the ’937 patent in support of

¹¹ U.S. Patent No. 7,234,937 B2 to Sachdeva *et al.*, issued June 26, 2007 (Ex. 1013, “the ’937 patent”).

Petitioner's contention that Sachdeva's morphable face model may be a 2D image. *Id.* ("Indeed, in a related patent, [the '937 patent (Ex. 1013), which shares most of the same specification, the inventors specifically noted that the morphable face model could be 2D.]); Ex. 1013, 11:33–38 ("In a less preferred embodiment, simple two dimensional data sets could be used, in which the 2 dimensional data sets are overlapped to create a virtual patient in two dimensions."); Ex. 1002 ¶ 305. Patent Owner contends that "as correctly pointed out by Dr. Mundy, the '937 patent explicitly discloses using two dimensional data to 'creat[e] the virtual patient ***without use of 3D data.***'" Resp. 31–32 (citing Ex. 2001 ¶ 305).

We refer again to Figure 7, reproduced below for ease of reference:



“FIG. 7 is a screen shot showing one possible method of placement of the lower jaw 30 data into the face data coordinate system using corresponding points that are common to each data set.” Ex. 1005, 4:57–60. Sachdeva discloses that, in Figure 7,

[t]he user is provided with the option to pick points that represent anatomical structures that are common to both the morphable model 102 and the 3D tooth model 104. In this particular situation, the user has selected with the mouse two points on the lower arches which lie at the intersection of the teeth and the gums. These two points are shown as a triangle 108 and a square 110. . . . The user then clicks on the “Apply” tab 112. The result is the 3D tooth model 104 is combined with the morphable face 102 model to produce a combined virtual patient model.

Id. at 14:35–45.

For reasons previously discussed, we find persuasive Petitioner’s contentions with respect to whether the morphable model is 2D versus 3D. Further, we are not persuaded that the ’937 patent supports Patent Owner’s argument that “in the case where a **2D** virtual patient model is created, such 2D virtual patient model is created utilizing a **2D** data set with another **2D** data set—not 3D data.” Resp. 31. First, we are not persuaded that Petitioner relies on the ’937 patent to cure any deficiencies of Sachdeva, but rather to aid in understanding Sachdeva. See Reply 4 (“In [the ’937] patent, with the same description of the ‘morphable model 102,’ dependent claim 33 ***provides that the combined digital representation comprises ‘superposition of a two dimensional representation and a three dimensional representation.’*** . . . A POSITA would not read Sachdeva inconsistent with how the same disclosure is read and claimed by the same inventor in another

nearly identical patent.” (citing Ex. 1013, 30:45–48; Ex.1023 ¶16)). Rather, Petitioner raised a “less preferred embodiment” of the ’937 patent as an example of the breadth of Sachdeva’s disclosure. Pet. 19; Ex. 1013, 11:33–38. We find the embodiment to be merely exemplary, rather than limiting, as Patent Owner contends.

Further, specific disclosures in the ’937 patent do not persuade us to reach a conclusion contrary to the express disclosure of Sachdeva. Sachdeva broadly discloses a workstation that “provides software features that create two dimensional and/or three-dimensional virtual patient model on a computer, which can be used for purposes of treatment planning.” Ex. 1005, 5:63–66.

Accordingly, consistent with Dr. Mundy’s testimony (Ex. 1002 ¶¶ 332–33), Sachdeva discloses icons, such as the “Align References” icon that produces the screen display of Figure 7, “that allow the user to position the tooth model 104 relative to the morphable model 102 in order to combine the two in a common coordinate system and construct a composite model.” Ex. 1005, 14:26–45. This describes arranging the morphable model (which maybe 2D or 3D) “such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint,” as recited in claim 1.

Patent Owner presents additional arguments that Sachdeva does not describe the 2D image and 3D virtual model being aligned while remaining separate representations. Resp. 34–42. According to Patent Owner, “[u]nlike the claimed approach of visualizing ‘separate representations’ in an

aligned state, Sachdeva employs the conventional approach of merging the images into one representation with all data included. *Id.* at 35; Ex. 2001

¶ 68. Patent Owner contends “Sachdeva explicitly discloses that the complete virtual patient model is a ***combined, composite model***, not two separate representations.” Resp. 35 (citing Ex. 1005 7:8–15).

Patent Owner references Sachdeva’s disclosure as follows:

After the images of the face, craniofacial structures, X-rays, teeth etc. are obtained and stored in memory in digital form they are superimposed on each other (i.e., registered to each other via software in the workstation) ***to create a complete virtual patient model*** on the workstation. The superposition of the sets of image data may be developed as an automatic software process, or one in which there is user involvement to aid in the process.

Resp. 35 (quoting Ex. 1005, 11:52–59). . Patent Owner also references Sachdeva’s disclosure as follows:

These functions include a function of automatically, and/ or with the aid of operator interaction via the user interface 14, superimposing the first set 24 of digital data and the second set 26 of digital data so as to provide ***a composite, combined digital representation*** of the craniofacial anatomical structures in a common coordinate system. ***This composite, combined digital representation is referred to herein occasionally as the “virtual patient model.”***

Resp. 35–36 (quoting Ex. 1005, 7:8–15). .

In view of this disclosure, Patent Owner contends “the superimposing or registering of data sets disclosed by Sachdeva results in creating a complete virtual patient model, which Sachdeva discloses is ***one composite, combined digital representation***” and that “[i]t is clear from the ’336 Patent

that the claimed ‘separate representations’ excludes superimposed images constituting ***one representation with all data included.***” Resp. 36.

We understand Patent Owner to argue that, in all cases, Sachdeva discloses that the virtual patient model combines the at least one 2D image and the 3D virtual model upon alignment such that the at least one 2D image and the 3D virtual model are no longer separate representations after being arranged. Resp. 34–42; Sur-Reply 9–17; Resp. 39–40 (“once the 3D face model 102 and the 3D tooth model 104 are aligned, neither the 3D tooth model 104 nor the 3D morphable model 102 ***remain*** separate representations after being arranged because they are combined to construct a composite model.”); Ex. 2001 ¶ 72 We find this argument unconvincing.

We have adopted Patent Owner’s construction that “arrange the at least one 2D image relative to the 3D virtual model in a virtual 3D space such that the at least one 2D image and the 3D virtual model are aligned when viewed from a viewpoint and remain separate representations after being arranged” means that the 2D image and the 3D virtual model must remain separate in their respective formats after the 2D image and the 3D virtual model are aligned when viewed from a viewpoint. *Supra* 9–2; see Resp. 6–7. We do not find persuasive that Sachdeva’s alignment process results in the data sets being combined into a composite model, upon alignment, that fails to preserve the respective formats of the data sets. Rather, we find Sachdeva discloses the opposite, namely that the image data and tooth model maintain independent formats so as to be capable of ongoing, independent manipulation. This is clear from the passages that

Patent Owner references. *See* Ex. 1005, 7:8–15 (“[W]ith the aid of operator interaction via the user interface . . . the first set 24 of digital data and the second set 26 of digital data [are superimposed] so as to provide a composite, combined digital representation”); 11:52–59 (“The superposition of the sets of image data may be [with] user involvement to aid in the process.”).

These passages describe an operator/user interacting with the data sets to thereby align them. Patent Owner has not directed us to persuasive evidence that, upon the condition of “alignment,” the formats of the respective data sets are merged such that ongoing manipulation through user interaction is precluded. That is, to whatever extent user interaction produces a superimposed or combined digital representation depicting alignment, Patent Owner has not direct us to sufficient evidence that after alignment the data sets are merged such that realignment—or refinement of the alignment—is precluded.

Thus, we are not persuaded by Patent Owner’s arguments that Sachdeva’s virtual patient model, resulting from the superimposition of the at least one 2D image and the 3D virtual model being merged into “a composite, combined digital representation,” negates their remaining separate representations after having been aligned when viewed from a viewpoint. Rather, we find Sachdeva to describe a workstation that provides an operator/user an ongoing ability to arrange two data sets (i.e., image data including lips and a tooth model) with respect to one another such that they

are “aligned when viewed from a viewpoint and remain separate representations after being arranged.” See Ex. 1005, 7:8–15, 11:52–59.

Support for our finding also comes from the following passage from Sachdeva, cited by Petitioner for the claim 1 limitation “where the restoration is designed to fit the at least one facial feature of the at least one 2D image” (Pet. 32–33):

The software instructions included in the craniofacial analysis module 326 preferably includes a set of instructions providing the user with user interface tools (e.g., icons), for visually studying on the user interface 316 the interaction of the craniofacial anatomical structures and their relationship to the external, visual appearance of the patient. For example, tools may provide a chewing simulation. Alternatively, the tools may provide a smile function in which the face is morphed to smile, showing the position of the teeth, gums, lips and other structures. These tools simulate changes in the anatomical position or shape of craniofacial anatomical structures (teeth, lips, skin, etc.) and show the effect of such changes on the visual appearance of the patient. As another example, the tools may include tools for modifying the shape or position of one or more bones of the upper and lower jaws, and show how those modifications affect the patient's appearance and smile.

With reference to FIG. 7, the user would activate one of the icons 35 at the top of the screen display. The icon may be associated with a function *that would allow the user to reposition the location of the upper and lower teeth. After the user changes the position of the teeth, the user would activate another icon, “smile”, and the face would morph to a smile with the teeth in the new position.*

Ex. 1005, 22:17–40 (emphasis added). This passage describes a return to the screen display of Figure 7 to thereby allow the user to again reposition the data sets with respect to one another well after a previously described

alignment process using the same screen display. *See id.* at 14:32–45. This is consistent with our determination that Sachdeva describes a workstation that provides an operator/user an ongoing ability to arrange two data sets (i.e., image data including lips and a tooth model) with respect to one another such that they are “aligned when viewed from a viewpoint and remain separate representations after being arranged.” If the data sets were merged or fused together, repositioning (i.e., realigning) the teeth as described here would not be possible.

Our determination here is consistent with Dr. Mundy’s testimony that Sachdeva describes “the representations are able to be pulled up separately later . . . , whether pulled up later in an aligned or non-aligned manner, because it shows that the representations remain in a separate format after the alignment occurs.” Ex. 1023 ¶ 30 (citing Ex. 1005, Fig. 67, 45:26–34). We find this more persuasive than Dr. Saber’s testimony that “[i]n Sachdeva, images are combined to form a complete virtual patient model which is visualized as a composite, combined representation, not ‘separate representations’ as required by the claims.” Ex. 2001 (citing Ex. 1005, 7:8–15. (“These functions include a function of automatically, and/ or with the aid of operator interaction via the user interface 14, superimposing the first set 24 of digital data and the second set 26 of digital data so as to provide **a composite, combined digital representation** of the craniofacial anatomical structures in a common coordinate system. **This composite, combined digital representation is referred to herein occasionally as the “virtual patient model.”**)). This isolated passage upon which Dr. Saber relies is not

broadly applicable, even if it were to require the merging or fusing of the data sets, to the other teachings of Sachdeva, such as the one to which Dr. Mundy refers (Ex. 1005, Fig. 67, 45:26–34) or the one to which we refer above (*id.* at 22:17–40).

Accordingly, we determine that Sachdeva discloses this limitation.

v. *“design a restoration for the 3D virtual model, where the restoration is designed to fit the at least one facial feature of the at least one 2D image . . . wherein the at least one 2D image and the 3D virtual model are aligned by scaling, translating or rotating the at least one 2D image or the 3D virtual model relative to each other”*

Petitioner contends Sachdeva discloses claim 1’s “design a restoration for the 3D virtual model, where the restoration is designed to fit the at least one facial feature of the at least one 2D image . . . wherein the at least one 2D image and the 3D virtual model are aligned by scaling, translating or rotating the at least one 2D image or the 3D virtual model relative to each other.” Pet. 31–33 (citing Ex. 1005, Fig. 6, 3:3–19, 7:36–38, 8:47-62, 11:63–12:8, 13:4-8, 47–59, 13:63–67, 14:46–47, 51–52; 15:40–19:52, 20:15–40, 24:18-55, 22:17–40, 29:11–13). Petitioner’s contentions are supported by the testimony of Dr. Mundy. Ex. 1002, ¶¶ 341–43, 344–50.

Patent Owner does not dispute that Sachdeva discloses these limitations. *See generally* Resp. 28–46; Sur-Reply 5–20.

Consistent with Petitioner’s contentions, Sachdeva discloses “[o]nce the user has modified the virtual patient model to achieve the patient’s desired feature and smile, it is possible to automatically back-solve for the teeth, jaw and skull movement or correction necessary to achieve this

result.” Ex. 1005, 19:14–16. Sachdeva also discloses “[a] module 304 contains instructions for designing custom dental and orthodontic appliances.” *Id.* at 20:15–16. *See id.* at 18:43–19:52 (describing “Treatment Planning”). Sachdeva also discloses “some approaches to scaling that may be performed in one possible embodiment of the invention.” *Id.* at 15:48–49. *See also id.* at 15:40–18:43 (describing “Scaling of Data”).

On this record, we are persuaded by Petitioner’s contentions that Sachdeva describes the foregoing limitations.

vi. *Conclusion*

In view of the foregoing analysis and based on our review of the complete record, Petitioner has demonstrated by a preponderance of the evidence that Sachdeva discloses all limitations of claim 1. For the same reasons, Petitioner has also demonstrated by a preponderance of the evidence that Sachdeva discloses all the limitations of claim 29. As discussed, claim 29 recites limitations that are nearly identical to those recited in claim 1.

(b) Dependent Claims 2–14, 16–20, 22–28, and 30

Claims 2–14, 16–20, 22–28 depend from claim 1 and claim 30 depends from claim 29. Petitioner contends Sachdeva anticipates claims 2–14, 16–20, 22–28, and 30. Pet. 33–48. Petitioner’s contentions are supported by the testimony of Dr. Mundy. Ex. 2001 ¶¶ 494–570.

i. *Claims 2–5, 10–14, 16–20, 22–28, and 30*

Patent Owner does not dispute Petitioner’s contentions regarding dependent claims 2–5, 10–14, 16–20, 22–28, and 30 separate from its

arguments concerning claims 1 and 29. Resp. 46–47 (“For the reasons discussed above with respect to claims 1 and 29, Sachdeva does not anticipate claims 2–28 and 30 which directly or indirectly depend from one of claims 1 and 29. Ex. 2001 at ¶ 81.”). We are persuaded by Petitioner’s uncontested evidence and arguments regarding these claims, as discussed in greater detail below.

We find that Sachdeva discloses the subject matter of claim 2 because it describes “facial feature are present in an image of the patient or in a generic image of a person” because morphable model 102 shows facial features. See Ex. 1005, Fig. 6. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 2, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 2 is unpatentable.

For claim 3, we agree with Petitioner that Sachdeva discloses “wherein the at least one facial feature comprises one or more imaginary lines of a face in the at least one 2D image” because Sachdeva describes drawing imaginary lines on the virtual model of the patient. Pet. 34; Ex. 1005, Fig. 24, 27:39–49. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 3, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 3 is unpatentable.

For claim 4, we agree with Petitioner that Sachdeva discloses “wherein the design of the restoration is performed to automatically fit the at least one facial feature of the at least one 2D image, and the 2D image is digital” because Sachdeva describes automatically with suitable pattern matching algorithms aligning the 3D tooth model and the morphable model.

Pet. 35; Ex. 1005, Fig. 28; 14:33–44, 29:13–17. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 4, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 4 is unpatentable.

For claim 5, we agree with Petitioner that Sachdeva discloses “wherein the at least one 2D image and the 3D virtual model are aligned based on one or more unprepared teeth” because Sachdeva describes the 2D image not having prepared teeth, and the aligning is performed using that 2D image. Pet. 35; Ex. 1005, 29:8–17, 14:40–45, 17:40–53. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 5, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 5 is unpatentable.

For claim 10, we agree with Petitioner that Sachdeva discloses “wherein the hardware processor is used to cut out a part of the at least one 2D image which is inside an edge of the lips.” Pet. 38; Ex. 1005, Fig. 6. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 10, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 10 is unpatentable.

For claim 11, we agree with Petitioner that Sachdeva discloses “wherein an edge of the lips is marked on the at least one 2D image.” Pet. 38–39; Ex. 1005, 17:46–53, 27:39–49. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 11, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 11 is unpatentable.

For claim 12, we agree with Petitioner that Sachdeva discloses “wherein a silhouette of a biting edge of at least upper anterior teeth on the at least one 2D image and on the 3D virtual model is used to perform the alignment of the at least one 2D image and the 3D virtual model.” Pet. 39; Ex. 1005, 14:32–45, 11:63–12:3. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 12, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 12 is unpatentable.

For claim 13, we agree with Petitioner that Sachdeva discloses “wherein the hardware processor is used to scale the at least one 2D image and the 3D virtual model to show at least part of teeth in a same size.” Pet. 40; Ex. 1005, 29:11–13. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 13, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 13 is unpatentable.

For claim 14, we agree with Petitioner that Sachdeva discloses “wherein the hardware processor is used to section at least two or more teeth in the 3D virtual model or in the at least one 2D image.” Pet. 40–41; Ex. 1005, 29:5–8, 7:53–55, 29:50–51, 44:1, 47:38–40. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 14, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 14 is unpatentable.

For claim 16, we agree with Petitioner that Sachdeva discloses “wherein arrangement comprises one or more virtual actions, wherein the virtual actions for arrangement comprise rotations and translations left/right

and back/forth of the at least one 2D image or of the 3D virtual model.”

Pet. 41–42. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 16, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 16 is unpatentable.

For claim 17, we agree with Petitioner that Sachdeva discloses “wherein texture from the at least one 2D image is mapped onto the 3D virtual model or the restoration.” Pet. 42 Ex. 1005, 14:4–7, 14:10–12, 31–62. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 17, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 17 is unpatentable.

For claim 18, we agree with Petitioner that Sachdeva discloses “wherein the method further comprises changing a perspective view of the at least one 2D image or of the 3D virtual model to obtain a same perspective view.” Pet. 42–43. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 18, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 18 is unpatentable.

For claim 19, we agree with Petitioner that Sachdeva discloses “wherein the method comprises determining an angle of the perspective view.” Pet. 43; Ex. 1005, 18:7–42. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 19, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 19 is unpatentable.

For claim 20, we agree with Petitioner that Sachdeva discloses “wherein an angle of the 3D virtual model and the at least one 2D image is

configured to adapt relative to the perspective view of the at least one 2D image.” Pet. 43–44. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 20, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 20 is unpatentable.

For claim 22, we agree with Petitioner that Sachdeva discloses “wherein the at least one 2D image is retrieved from a library comprising a number of images of teeth.” Pet. 44; Ex. 1005, 39:4–6. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 22, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 22 is unpatentable.

For claim 23, we agree with Petitioner that Sachdeva discloses “wherein the at least one 2D image is a template for supporting designing teeth of the patient.” Pet. 44; Ex. 1005, 20:15–22, 39:4–6. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 23, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 23 is unpatentable.

For claim 24, we agree with Petitioner that Sachdeva discloses “wherein the at least one 2D image shows a facial feature in the form of at least a number of front teeth.” Pet. 45; Ex. 1005, 7:17–19, Fig. 22. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 24, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 24 is unpatentable.

For claim 25, we agree with Petitioner that Sachdeva discloses “wherein the at least one 2D image is an Xray image of teeth of the patient.”

Pet. 45; Ex. 1005, Fig. 9; *see also* 4:54–55, 15:1–24, Fig. 10, 4:66–67, 15:30–39, 6:51–53, 7:19–21, 7:29–35, 9:40–50, 10:46–51, 12:7–8, 11:52–63, 13:10–17, 28:59–29:2, 35:49–55, 43:52–53; 45:26–31, 47:62–65.

Accordingly, we find that Sachdeva teaches the limitations in dependent claim 25, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 25 is unpatentable.

For claim 26, we agree with Petitioner that Sachdeva discloses “wherein the at least one facial feature comprises teeth; and wherein the hardware processor is used to detect anatomical points on the teeth, where the anatomical points are present and detectable both on the one or more 2D images and the 3D virtual model, and perform virtual actions for arrangement based on corresponding anatomical points on the one or more 2D image and the 3D virtual model.” Pet. 46–47; Ex. 1005, Fig. 7, 4:57–60, 14:32–44, 11:63–8. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 26, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 26 is unpatentable.

For claim 27, we agree with Petitioner that Sachdeva discloses “wherein the designed restoration is configured for manufacturing a corresponding dental restoration.” Pet. 47; Ex. 1005, 9:31–33, 20:15–40, 21:25–34. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 27, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 27 is unpatentable.

For claim 28, we agree with Petitioner that Sachdeva discloses the “nontransitory computer readable medium encoded with a computer

program for causing a data processing system to perform the method of claim 1, when said program code is executed on the data processing system.” Pet. 48; Ex. 1005 Abstract.

For claim 30, we agree with Petitioner that Sachdeva discloses “wherein the designed restoration is configured for manufacturing a corresponding dental restoration.” Pet. 47; Ex. 1005, 9:31–33, 20:15–40, 21:25–34. Accordingly, we find that Sachdeva teaches the limitations in dependent claim 30, and we conclude that Petitioner has proven by a preponderance of the evidence that claim 30 is unpatentable.

ii. *Claim 6–9*

Claim 6 depends from claim 1 and recites “wherein the hardware processor is used to provide two 3D virtual models, where the first 3D virtual model comprises at least one prepared tooth and the second 3D virtual model comprises no prepared teeth, and where the first and the second 3D virtual models are aligned.” Petitioner states “Sachdeva discloses making the arrangement of the 2D image and 3D models without specifying whether the teeth are prepared are unprepared,” but contends “the multiple models would be used in that manner if prepared teeth were used, and also the software functions the same regardless of the nature of the 3D model.” Pet. 36 (citing Ex. 5001, 9:56–58, 10:14, and 11:59–12:8); Ex. 1002 ¶¶ 365–71).

Patent Owner argues that “Sachdeva has no mention of prepared teeth” and “Sachdeva does not disclose a 3D virtual model comprising a

prepared tooth, much less aligning a first 3D virtual model comprising at least one prepared tooth and a second 3D virtual model comprising no prepared teeth.” Resp. 46–47. Patent Owner argues claims 7 and 8 based on dependency from claim 6. *Id.* at 47.

Patent Owner does not dispute that Sachdeva discloses that the virtual models comprise “teeth.” *See generally id.* at 46. We understand Patent Owner to argue that Sachdeva does not anticipate claims 6–8 because Sachdeva does not mention a “prepared tooth.”¹²

Petitioner correctly points out that even Patent Owner’s expert, Dr. Saber, acknowledges Sachdeva functions the same way whether the teeth are prepared or unprepared. Reply. 14–15 (citing Ex. 1026, 176:21–179:7). Petitioner’s expert, Dr. Mundy, testifies that because the functions of Sachdeva apply to **any** type of teeth, prepared or unprepared, Sachdeva discloses creating the virtual models including both prepared and unprepared teeth, and thus meets these limitations. *Id.* at 14 (citing Ex.1023 ¶ 41).

We find Dr. Mundy’s testimony persuasive, particularly in view of the lack of difference between prepared versus unprepared teeth in Sachdeva’s functionality. Ex.1023 ¶ 41; Ex. 1026, 176:21–179:7. Because there is no difference in functionality, we find no reason a POSITA would exclude

¹² To whatever extent Patent Owner is arguing claims 6–8 because Sachdeva does not disclose aligning multiple 3D models, we are unpersuaded of error in view of our determinations *infra* that Sachdeva describes a “representative and non-limiting example” of operating on data sets that include both two-dimensional and three-dimensional image information acquired from a variety of sources. Ex. 1005, 6:45–61.

either prepared teeth or unprepared teeth from Sachdeva's disclosure of "teeth" broadly. Ex. 1005, 9:56–58, 10:14, and 11:59–12:8

Claim 9 recites that "the hardware processor is used to virtually cut at least a part of teeth out of the at least one 2D image." Patent Owner points out that "Claim 9 does not recite the alternative of 'render a part of the at least one 2D image that includes teeth at least partly or wholly transparent' recited in claim 1," but otherwise argues claim 9 on the same basis as claim 1. Resp. 47; Ex. 2001 ¶ 84. Because we determine Sachdeva's tools "for hiding and displaying various aspects of the virtual patient model, soft tissue, occlusal planes, and other features of the software" describe tools usable to "virtually cut at least a part of teeth out of the at least one 2D image" (*infra* (citing (Ex. 1005, 30:8–12))), Patent Owner's contentions with respect to claim 9 are unpersuasive.

3. Summary of Anticipation Challenge based on Sachdeva

For the foregoing reasons, we determine claims 1–14, 16–20, and 22–30 are anticipated by Sachdeva. Pet. 16–48; *see* Ex. 1002 ¶¶ 466–570; Ex 1023 ¶¶ 10–17. We have considered Patent Owner's arguments in the Response and Sur-Reply and the testimony of Patent Owner's Expert. Resp. 28–47; Sur-Reply 2–20; Ex. 2001 ¶¶ 60–84. Based on our review of the complete record, Petitioner has demonstrated by a preponderance of the evidence that claims 1–14, 16–20, and 22–30 are unpatentable.

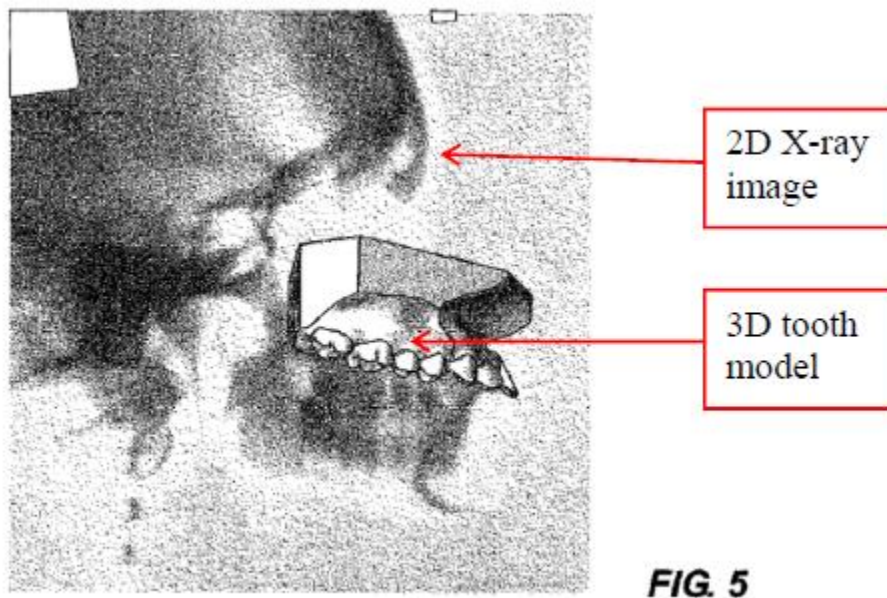
E. Obviousness Under § 103 over Sachdeva and Kopelman

Petitioner contends that claims 1–14, 16–20, and 22–30 would have been obvious over Sachdeva in combination with Kopelman. Pet. 55–82.

Patent Owner disputes Petitioner's contentions on the basis that "Kopelman fails to cure the above-described deficiencies of Sachdeva" and "[t]here is no reason with rational underpinnings as to why a POSITA would have combined Sachdeva with Kopelman as Petitioner alleges." Resp. 47. See Ex. 2001 at ¶ 85.

1. Kopelman (Ex. 1008)

Kopelman discloses a dental imaging processing method/system that is used to design a dental restoration. Ex. 1008, 1:43–60. Kopelman discloses taking a 2D image, such as an X-ray (*id.* at Fig. 1A), and a 3D image of the patient's teeth (*id.* at Fig. 1B), and combining the 2D and 3D images, as shown in Figure 5, reproduced below with annotations from the Petition.



Kopelman Figure 5 with annotations depicting a 2D X-ray image and a 3D tooth model as reproduced from the Petition. Pet. 56 (Ex. 1008, Fig. 5).

2. Analysis

Petitioner contends that “if the Board were to accept an argument that Sachdeva discloses only a 3D face model and not also 2D face image, for the ‘morphable model 102’ [then] . . . it nonetheless would have been obvious to combine Sachdeva with Kopelman[’s]” 2D face image. Pet. 79. For support, the Petition includes claim charts detailing how claims 1–14, 16–20, and 22–30 read on the combination of Sachdeva and Kopelman, and relies on the testimony of Dr. Mundy. Pet. 57–79; *see* Ex. 1002 ¶¶ 467–568.

Patent Owner does not dispute that Kopleman discloses combining a 2D image with a 3D model, but rather argues that “there is no reason with rational underpinnings to substitute Sachdeva’s 3D model with Kopelman’s 2D image . . . because Sachdeva already discloses providing a 3D morphable model.” Resp. 48. *See* Ex. 2001 ¶¶ 87–89.

Contrary to Patent Owner’s arguments, the Petition provides numerous reasons for combining the teachings of Sachdeva and Kopelman, which are supported by the testimony of Dr. Mundy. Pet. 79–83; Ex. 1002 ¶¶ 574–80. For example, Dr. Mundy testifies that “[t]he teachings of both Sachdeva and Kopelman themselves also would have motivated a [person having ordinary skill in the art] to modify Sachdeva to include aligning/visualizing 2D images with 3D models.” Ex. 1002 ¶ 579. Dr. Mundy explains that because “Sachdeva teaches combining *other* 2D images with 3D tooth models . . . a POSITA would have been motivated to also allow the system in Sachdeva to use a morphable face model 102 that is 2D.” *Id.* (citing Ex. 1005, Figs. 5A, 28 and 13:41–50, 28:59–29:31). He

adds that “the teachings of Kopelman, which discloses aligning and visualizing a 2D image with a 3D model, would also have motivated a POSITA to combine it with Sachdeva.” *Id.* Dr. Mundy states, “Kopelman teaches the benefits of combining a 2D image with a 3D tooth model, including describing that it is desirable because it allows for better analysis for orthodontic treatment.” *Id.* (citing Ex. 1008, 1:52–56).

Petitioner’s reasons for combining Sachdeva and Kopelman are persuasive. We particularly note Dr. Mundy’s testimony that another reason to add the aligning 2D-to-3D feature to Sachdeva would have been

the general ease of obtaining 2D images of the face, including with a camera on every cell phone. A POSITA would have been aware of the prevalence of available 2D images of the patient and the desire to simply use such 2D photos in the analysis, rather than 3D images, particularly being aware of how 2D photos may readily be available, while 3D face scanners might not be so prevalent. Given this design need, a POSITA would have sought to modify Sachdeva such that it could accommodate aligning the 2D image of a patient’s face with the 3D tooth model.

Ex. 1002 ¶ 580. We find this reasoning more credible than Dr. Saber’s testimony that “[r]eplacing the 3D morphable model of Sachdeva with a 2D image as Petitioner suggests would have defeated the purpose of [Sachdeva’s] converting the 2D color pictures into a 3D morphable model in the first place.” Ex. 2001 ¶ 87. Dr. Saber does not state what Sachdeva’s purpose is that would be defeated by accommodating alignment using a 2D image with the 3D tooth model. In contrast, Dr. Mundy explains that the use of 2D images for the alignment process would simplify Sachdeva’s process

by avoiding the conversion of the 2D images into a 3D model. Ex. 1002 ¶ 580.

Patent Owner also contends that, like Sachdeva, Kopelman does not disclose that the 2D image and the 3D model “remain separate representations after being arranged.” Resp. 50–54; Sur-Reply 20–21. Additionally, Patent Owner argues that “Petitioner makes no assertion that it would have been obvious to modify Sachdeva (alone or in view of Kopelman) to arrive at the claimed feature” relating to rendering part of the image, including teeth, transparent. Resp. 55–56. As discussed, we determine that Sachdeva discloses “the at least one 2D image and the 3D virtual model . . . remain separate representations after being arranged.” Further, we note, as Petitioner points out, that Kopelman teaches the use of 2D x-ray images that are partly transparent. Pet. 60 (citing Ex. 1008, Fig. 3). Dr. Mundy’s testimony is consistent with the disclosure of Kopelman. Ex. 1002, ¶¶ 476–77.

Accordingly, although we disagree with Patent Owner that Sachdeva does not teach a 2D face image, we are, nevertheless, persuaded that even if Sachdeva were found not to teach a 2D face image, Petitioner has provided sufficient explanation for why a person having ordinary skill in the art would have modified Sachdeva to include a 2D image. Pet. 79–83. Further, Kopelman teaches that the 2D image may be a partly transparent x-ray image. Ex. 1008, Fig. 3.

Thus, in view of the foregoing and our review of the complete record, we conclude that the Petition demonstrates by a preponderance of the

evidence that claims 1 and 29 are unpatentable as obvious over Sachdeva and Kopelman.

Petitioner argues that claims 2–14, 16–20, 22–28, and 30 are unpatentable as obvious over Sachdeva and Kopelman. Pet. 66–79. Patent Owner does not address the dependent claims of this challenge separately from its arguments directed at claims 1 and 29. *See generally* Resp. 47–56; Sur-Reply 20–21. As discussed *infra*, Petitioner relies on Kopelman solely for a 2D image. Thus, for the same reasons discussed with respect to Petitioner’s anticipation challenge based on Sachdeva, Petitioner has shown by a preponderance of the evidence that claims 2–14, 16–20, 22–28, and 30 are unpatentable as obvious over Sachdeva and Kopelman. *See* Pet. 55–79.

F. Obviousness Under § 103 over Sachdeva, Kopelman, and Lehmann

Petitioner contends that Lehmann in combination with Sachdeva and Kopelman renders claim 15 obvious. Pet. 83 (citing Ex. 1010, 3–4 and Fig. 3). Lehmann relates to image interpolation in medical imaging. Ex. 1010, 1. Claim 15 recites “the alignment of the 3D virtual model and the at least one 2D image for one or more perspective views is performed by interpolation or extrapolation of other perspective views.” Petitioner contends it would have been obvious to combine Sachdeva with Lehmann for the purpose of “adding a known technique such that different perspective views are available.” Pet. 83 (referring to Pet. 51–53). Petitioner’s contentions are supported by Dr. Mundy’s testimony. Ex. 1002 ¶¶ 581–85.

Patent Owner's Response regarding claim 15 argues that Lehman "fail[s] to cure the [] deficiencies of [Wiedmann, Sachdeva, and Kopelman]. Resp. 61. Because we do not find these deficiencies in Sachdeva and Kopelman, we are not persuaded by Patent Owner's arguments. Moreover, we find that Lehmann discloses "the alignment of the 3D virtual model and the at least one 2D image for one or more perspective views is performed by interpolation or extrapolation of other perspective views." Ex. 1010, Fig. 3, 1051–52. Further, we determine that Petitioner has explained sufficiently why a POSITA would have combined Sachdeva and Kopelman with Lehman. Pet. 83 (citing Ex. 1002 ¶¶ 581–85). Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that claim 15 is unpatentable.

G. Obviousness Under § 103 over Sachdeva, Kopelman, and Seeger

Petitioner contends that Seeger in combination with Sachdeva and Kopelman renders claim 21 obvious. Pet. 83–84 (citing Ex. 1011 ¶¶ 7, 10, 44–47). Claim 21 recites "de-warping [a] perspective view of the at least one 2D image for visually aligning the at least one 2D image and the 3D virtual model." Seeger relates to digital image capture and discloses "[d]ewarping techniques are known for geometrically transforming an image to correct the perspective distortion." Ex. 1011 ¶ 10. Petitioner contends a person having ordinary skill in the art "would have recognized that the alignment would be better without distortion in the 2D image" and thus would have combined Seeger and Sachdeva to add the de-warping feature to

change the perspective of an image. Pet. 83–84. Petitioner’s contentions are supported by Dr. Mundy’s testimony. Ex. 1002 ¶¶ 586–88.

Patent Owner’s Response regarding claim 21 argues that Seeger “fail[s] to cure the [] deficiencies of [Wiedmann, Sachdeva, and Kopelman].” Resp. 61. Because we do not find these deficiencies in Sachdeva and Kopelman, we are not persuaded by Patent Owner’s arguments. Moreover, we find that Seeger discloses “de-warping [a] perspective view of the at least one 2D image for visually aligning the at least one 2D image and the 3D virtual model.” Ex. 1011 ¶¶ 7, 10, 44–47. Further, we determine that Petitioner has explained sufficiently why a POSITA would have combined Sachdeva and Kopelman with Seeger. Pet. 83-84 (citing Ex. 1002, ¶¶ 586–88).

H. Obviousness under § 103 over Sachdeva, Kopelman, and MacDougald,

Claim 6 depends from claim 1 and recites providing two virtual 3D models, “the first 3D virtual model comprises at least one prepared tooth and the second 3D virtual model comprises no prepared teeth, and where the first and the second 3D virtual models are aligned.” Claim 7 depends from claim 6 and recites “the at least one 2D image and the second 3D virtual model comprising no prepared teeth are aligned.” Claim 8 depends from claim 7 and recites “the at least one 2D image and the first 3D virtual model comprising at least one prepared tooth are aligned based on the alignment between the first and the second 3D virtual model and based on the

alignment between the at least one 2D image and the second 3D virtual model.”

Petitioner contends that, to the extent these elements are not disclosed in Sachdeva without MacDougald, it would have been obvious based on the combined teachings of Sachdeva and MacDougald to use a 3D model of prepared teeth and a 3D model of unprepared teeth in designing the restoration. Pet 84 (referring to Pet. 53–55). Petitioner contends “[t]here are a limited number of types of tooth models a user can use, and . . . Sachdeva [does] not limit the types of tooth models.” *Id.*

For claims 6, 7, and 8, the Petition relies on the testimony of Dr. Mundy. *Id.* (citing Ex. 1002 ¶¶ 589–91). Dr. Mundy describes specific sections from MacDougald and explains how claims 6–8 read on MacDougald. Ex. 1002 ¶ 590 (citing Ex. 1009, 1:56–65, 2:32–3:34, 3:35–46); see Pet. 54. Dr. Mundy testifies that combining Sachdeva and MacDougald would have been obvious to use a 3D model of prepared teeth and a 3D model of unprepared teeth in designing the restoration because “there are a limited number of types of tooth models a user can use, and Sachdeva does not limit the types of tooth models.” *Id.* at ¶ 591.

Patent Owner first argues that “MacDougald fails to cure the deficiencies of Wiedmann, Sachdeva, and Kopelman with respect to claim 6.” Resp. 57. Patent Owner next argues: “[a] POSITA would not have had a reason with rational underpinnings to combine Sachdeva and MacDougald to arrive at providing two 3D models, one comprising a prepared tooth and

one not comprising any prepared tooth, in an aligned state.” *Id.* at 59. *See* Ex. 2001 ¶¶ 96–100.

Because we do not find deficiencies with respect to Sachdeva and claims 6–8 (*supra* 53–55), we are not persuaded by Patent Owner’s first argument. Patent Owner’s next argument is unpersuasive to the extent it imports the “aligned” limitation into the analysis. Petitioner does not rely on MacDougald for the “aligned when viewed from a viewpoint” limitation as Patent Owner contends. Ex. 2001 ¶ 98; *see id.* at ¶ 99 (“In MacDougald, while the prepared tooth data is subtracted from the original tooth data, the prepared tooth data is never aligned with original tooth data.”).

Accordingly, based on our review of the entire record, we find Petitioner’s position is persuasive because it is supported by an analysis of the relevant references and supporting evidence, including citations to the record. Pet. 83–84 (citing Ex. 1002 ¶¶ 581–91). The Petition demonstrates by a preponderance of the evidence that claims 6–8, 15, and 21 are unpatentable as obvious.

G. Challenges Based on Wiedmann

In Petitioner’s first, second, third, and fourth proposed grounds of unpatentability, Wiedmann is the primary reference. Pet. 2. Specifically, Petitioner contends that claims 1–5, 7–11, 13, 14, 16–18, 22–24, 27–30, would have been anticipated by Wiedmann, and that claims 1–14, 16–20, and 22–30 would have been obvious over Wiedmann and Sachdeva. *Id.* at 12–51. In challenging claim 15, Petitioner adds Lehman to the combination of Wiedmann and Sachdeva. *Id.* at 51–53. In challenging claim 21,

Petitioner adds Seeger to the combination of Wiedmann and Sachdeva. *Id.* at 53. In challenging claims 6–8, Petitioner adds MacDougald to the combination of Wiedmann and Sachdeva. *Id.* at 53–55.

In a final decision, the Board is required to address the patentability of all claims challenged in a petition. *See* 35 U.S.C. § 318(a) (providing that the Board “shall issue a final written decision with respect to the patentability of any patent claim challenged by the petitioner and any new claim added” by amendment during the proceeding); *SAS Inst. Inc. v. Iancu*, 138 S.Ct. 1348, 1354 (2018) (“[W]hen § 318(a) says the Board’s final written decision ‘shall’ resolve the patentability of ‘any patent claim challenged by the petitioner,’ it means the Board *must* address *every* claim the petitioner has challenged.”); Guidance on the Impact of SAS on AIA Trial Proceedings (Apr. 26, 2018)¹³ (“[I]f the PTAB institutes a trial, the PTAB will institute on all challenges raised in the petition The final written decision will address, to the extent claims are still pending at the time of decision, all patent claims challenged by the petitioner and all new claims added through the amendment process.”).

However, we are not aware of any requirement that once all challenged claims have been determined unpatentable, the Board must go on to analyze additional grounds challenging the same claims.¹⁴ In some cases,

¹³ Available at www.uspto.gov/patents-application-process/patent-trial-andappeal-board/trials/guidance-impact-sas-aia-trial.

¹⁴ We note that in *Adidas AG v. Nike, Inc.*, 894 F.3d 1256 (Fed. Cir. 2018), the Federal Circuit remanded to the Board to consider a second ground when

doing so is an inefficient use of the Board’s resources, in that it may detract from the time and attention that is available to analyze and explain our reasoning for the dispositive issues. In this regard, an early Federal Circuit decision concerning the International Trade Commission explained that an administrative agency “is at perfect liberty” to reach a decision based on a single dispositive issue because doing so “can not only save the parties, the [agency], and [the reviewing] court unnecessary cost and effort, it can greatly ease the burden on [the agency] faced with a . . . proceeding involving numerous complex issues and required by statute to reach its conclusion within rigid time limits.” *Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984).

the Board’s final decision had only addressed a first ground covering the same claims. *Id.* at 1258. But in *Adidas*, the Board’s final decision held that the challenged claims were not unpatentable based on the first ground. *Id.* at 1257. Thus, unlike the circumstances here, the Board’s decision in *Adidas* was not dispositive of the petitioner’s challenges. Similarly, in *AC Technologies S.A. v. Amazon.com, Inc.*, 912 F.3d 1358 (Fed. Cir. 2019), the Federal Circuit held that the Board properly considered a ground on which it did not initially institute, when the originally non-instituted ground challenged claims that were not shown unpatentable based on the originally instituted grounds. *Id.* at 1364–65. The reasoning of *AC Technologies* is that SAS requires the Board to address all claims challenged by a petitioner, so a final decision holding that some challenged claims were not shown unpatentable without addressing all of the grounds presented in the petition would violate the statutory scheme. *Id.* But we do not understand *AC Technologies* to require the Board to address grounds that challenge claims that have already been held unpatentable on other grounds.

Here, the grounds led by Wiedmann (i.e., grounds 1–4) challenge claims we have already determined are unpatentable based on the grounds led by Sachdeva (i.e., grounds 4–8). *See supra* 16–64. Except for Wiedmann and Kopelman, Petitioner’s grounds 1–4 include the same references as grounds 5–8. *See* Pet. 2–3. Kopelman is relevant only to claim limitations that are anticipated by Sachdeva. *See supra* 55–61. Thus, because we have already determined all challenged claims are unpatentable over the references in grounds 1–4 without Wiedmann, the additional analysis of grounds 1–4 would be cumulative. Accordingly, we decline to address the challenges presented in Petitioner’s grounds 1–4.

III. PATENT OWNER’S MOTION TO STRIKE AND MOTION TO EXCLUDE EVIDENCE

Patent Owner filed a Motion to Strike portions of Petitioner’s Reply to Patent Owner’s Response. Paper 30. *See* Paper 26. Patent Owner also filed a Motion to Exclude Evidence. Paper 36. *See* Exhibit 1023. Specifically, Patent Owner “requests that the Board strike Section IV.D.3. of Petitioner’s Reply” and “requests exclusion of Section VI.C. (pages 27–29) of Exhibit 1023 as inadmissible under the Federal Rules of Evidence.” Paper 30, 1; Paper 36, 1. The subject portions of Petitioner’s Reply and corresponding evidence address reasons why a POSITA would have modified Wiedmann to arrive at certain limitations of the claims. *See* Reply 23–24; Exhibit 1023. Petitioner opposed the Motion to Strike and the Motion to Exclude. Papers 32, 37. Patent Owner filed a Reply in Support of the Motion to Exclude. Paper 38.

Because the subject portions of Petitioner’s Reply and corresponding evidence relate to Petitioner’s challenges based on Wiedmann—challenges we have declined to address for reasons previously discussed (*see infra*)—Patent Owner’s motions are moot. Accordingly, we dismiss Patent Owner’s Motion to Strike and Motion to Exclude Evidence. Papers 30, 36.

IV. CONCLUSION¹⁵

Reference(s)	Basis	Claims	Claims Shown Unpatentable	Claims Not shown Unpatentable
Sachdeva	§ 102	1–14, 16–20, and 22–30	1–14, 16–20, and 22–30	
Sachdeva and Kopelman	§ 103	1–14, 16–20, and 22–30	1–14, 16–20, and 22–30	
Sachdeva, Kopelman, and Lehmann	§ 103	15	15	

¹⁵ 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. 16654 (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).

Sachdeva, Kopelman, and Seeger	§ 103	21	21	
Sachdeva, Kopelman, and MacDougald	§ 103	6–8	6–8	
Overall Outcome			1–30	

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–30 of the '336 patent are unpatentable;

FURTHER ORDERED that Patent Owner's Motion to Strike and Motion to Exclude Evidence are dismissed as moot; and

FURTHER ORDERED that because this is a final written decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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