

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

ALIGN TECHNOLOGY, INC.,
Patent Owner.

IPR2019-00134
Patent 9,299,192 B2

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

McNAMARA, *Administrative Patent Judge*.

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

I. BACKGROUND

On July 22, 2019, we instituted an *inter partes* review of claims 1–5 and 8–32 (the challenged claims) of U. S. Patent No. 9,299,192 B2 (“the ’192 Patent”). Paper 8 (“Dec. to Inst.”). Patent Owner filed a Patent Owner Response (Paper 12, “PO Resp.”), Petitioner filed a Petitioner Reply (Paper 16, “Pet. Reply”), Patent Owner filed a Patent Owner Surreply (Paper 18, “PO Surreply”) and a transcript of an oral hearing held on April 15, 2020 (Paper 27, “Hrg. Tr.”) has been entered into the record.

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. §318(a). We base our decision on the preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

Having reviewed the arguments of the parties and the supporting evidence, we conclude that Petitioner has demonstrated by a preponderance of the evidence that the challenged claims are unpatentable.

II. THE ’192 PATENT

The ’192 patent concerns “modifying a virtual model of a physical structure with additional 3D data obtained from the physical structure to provide a modified virtual model.” Ex. 1001, Abstract. The method and apparatus is described in the context of dental technology, where, for example, a finish line (i.e., a transition boundary between a prosthesis and a dental preparation) may be obscured by soft tissue, such that a virtual model based on scanned data is incomplete or defective. *Id.* 1:30–2:24. One aspect of the invention is modifying a virtual model of a physical structure, such as a patient’s intraoral cavity or a physical part of a physical structure. *Id.* at 4:4–6, 16–24. A computer based method includes displaying an image of the virtual model on a display connected to a computer system, interacting with the displayed image to identify a portion of the virtual model to be

modified, and modifying the virtual model by replacing in the computer system the portion of the virtual model to be modified with additional 3D data obtained from the physical structure. *Id.* at 4:5–15.

III. ILLUSTRATIVE CLAIM(S)

Claim 1 (drawn to a method), claim 28 (drawn to an apparatus), and claim 30 (drawn to a non-transitory computer readable medium having a program stored thereon) are independent. Claim 1, reproduced below, is illustrative of the claimed subject matter:

1. A method for generating a modified virtual model of a physical structure, comprising:
 - (A) displaying an image of a first virtual model on a display operatively connected to a computer system, wherein the first virtual model is generated from first 3D scan data of the physical structure, and wherein said first virtual model fails to properly represent a first physical part of the physical structure;
 - (B) receiving user input identifying at least a portion of the first virtual model that is desired to be modified, wherein the user input is generated by user interaction with the image on the display;
 - (C) receiving a second virtual model of the physical structure with the computer system, the second virtual model generated from second 3D scan data of the physical structure; and
 - (D) modifying the first virtual model with the computer system by replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model, thereby generating the modified virtual model.

IV. GROUNDS OF INSTITUTION

Trial was conducted on all of the grounds asserted in the Petition, as summarized in the following table:

Claims	Statutory Basis	Challenge
1–5, 8–13, 15–23, 25–32	35 U.S.C. § 103	Paley, ¹ Kriveshko ²
14	35 U.S.C. § 103	Paley, Kriveshko, and Babayoff ³
24	35 U.S.C. § 103	Paley, Kriveshko and Chishti ⁴

V. CLAIM CONSTRUCTION

The filing date accorded the Petition is November 9, 2018. In the case of petitions for *inter partes* review filed before November 13, 2018, we interpret claims of an unexpired patent using the broadest reasonable construction in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b)(2018)⁵; *Cuozzo Speed Techs. LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016). In applying a broadest reasonable construction, claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the

¹ U.S. Patent Appl. Publ. No. 2007/0172112 A1, published Jul. 26, 2007 (Ex. 1006).

² U.S. Patent Appl. Publ. No. 2007/0236494 A1, published Oct. 11, 2007 (Ex. 1007).

³ U.S. Patent Appl. Publ. No. 2003/0232302 A1, published Dec. 18, 2003 (Ex. 1008).

⁴ U. S. Patent No. 6,227,850, issued May 8, 2001 (Ex. 1009).

⁵ A recent amendment to this rule does not apply here. *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (amending 37 C.F.R. § 42.100(b) effective November 13, 2018).

context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definition for a claim term must be set forth in the specification with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In our Decision to Institute, we applied Petitioner’s unopposed proposal that each of the terms “virtual model,” “3D virtual model,” “second virtual model,” and “second 3D virtual model” be construed to mean “virtual representation in a computer environment of a real object.” Dec. to Inst. 7. We also applied Petitioner’s unopposed assertions that “virtual model” and “3D virtual model” are interchangeable terms and that “second virtual model” and “second virtual 3D model,” be construed to mean “a singular and collected virtual representation,” because “second virtual model” and “second virtual 3D model” mean structurally more than additional data from the physical structure. *Id.* Neither party proposed any other constructions prior to institution. The Patent Owner Response filed after institution proposes different constructions. PO Resp. 25–32. We address the proposed claim constructions below.

A. Virtual model/3D virtual model

Patent Owner proposes “virtual model” and “3D virtual model” be construed to mean “3D virtual representation.” PO Resp. 25. Patent Owner states that Petitioner agreed to Patent Owner’s proposed construction in a parallel ITC proceeding and that Patent Owner’s proposed construction is “not meaningfully different in scope” from Petitioner’s proposed construction, i.e., “virtual representation in a computer environment of a real

object.”⁶ *Id.* at 25–26. Patent Owner argues Petitioner’s proposed language “in a computer environment of a real object” is not necessary to the construction, as that feature is already implied by the term “virtual representation.” *Id.* at 26. Petitioner agrees the constructions are “not meaningfully different.” Pet. Reply. 1. We agree that in the context of the ’192 Patent, a model is a representation of a real object and that a virtual model is a representation of a real object in a computer environment. Therefore, recognizing there is no meaningful difference between Petitioner’s and Patent Owner’s proposed constructions, for purposes of this Decision, we construe “virtual model” and “virtual 3D model” as a “virtual representation in a computer environment of a real object.”

B. Second virtual model/second virtual 3D model

In our Decision to Institute, we applied Petitioner’s unopposed proposed construction that all the virtual models should be construed to mean “virtual representation in a computer environment.” Dec. to Inst. 7–8. We also noted Petitioner’s assertion that the second virtual model and second virtual 3D model refer to a “singular and collected virtual representation.” *Id.* at 7. Petitioner contends the second virtual model and second virtual 3D model are “singular and collected” to indicate the second virtual model replaces a portion of the first virtual model and is more than just additional data from the physical structure. *Id.*

⁶ See Ex. 2010, *In the matter of Certain Dental and Orthodontic Scanners and Software*, Inv. No. 337-TA-1144, Order 36 (Oct. 1, 2019), referred to herein as “the ITC Proceeding.” Subsequent to the oral hearing in this proceeding, the ITC Proceeding was identified in a Mandatory Notice filed by Patent Owner on May 19, 2020. Paper 28.

The Patent Owner Response contends that the terms “singular” and “collected” are not required, as “first” and “second” distinguish the first and second virtual models. PO Resp. 27. Patent Owner contends there is no basis for defining the second virtual model differently from the first virtual model, arguing that “singular” and “collected” are not found in the intrinsic record, that the meaning of this terminology and its effect on the claim scope is unclear. *Id.* at 28.

We agree with Patent Owner. Claim 1 recites a “the first virtual model is generated from first 3D scan data of the physical structure” and a “the second virtual model [is] generated from second 3D scan of the physical structure.” The claim language does not limit the second virtual model to a “singular and collected” model. Thus, recognizing the claim language distinguishes the first and second virtual models as being generated from images taken in first and second scans, respectively, for purposes of this Decision, we construe the second virtual model to be a “virtual representation in a computer environment of a real object.”

C. Identifying at least a portion of the first virtual model that is desired to be modified

Our Decision to Institute did not include a construction of the limitation in claim 1 Step (B) that recites “identifying at least a portion of the first virtual model that is desired to be modified” (“the Identifying Term”). Neither the Petition nor the Patent Owner Preliminary Response asserted this term required construction. Patent Owner now contends that in the corresponding ITC proceeding both parties agreed the proper construction of the Identifying Term is “identifying at least a portion *on* the first virtual model that is desired to be *replaced*.” PO Resp. 29 (emphasis by Patent Owner).

Claim 1 Step (B) recites “receiving user input identifying at least a portion of the first virtual model that is desired to be modified.” Thus, the issue before us is the meaning of the “user input identifying a portion of the first virtual model that is desired to be modified.” Claim 1 does not limit that input to any particular form of identification, other than by reciting “wherein the user input is generated by user interaction with the image on the display.” For example, the user input is not limited to specifying a tooth number, as the model can use any form of identification that suitably specifies a portion of the model desired to be modified. *See, e.g.*, Ex. 1001, 4:25–27 (“For example, step (B) comprises identifying on said first display image a first display image portion thereof by interacting with said display”); *id.* at 14:63–65 (“identifying surface data ID of second virtual model VM2 may be useful as it may be aligned with corresponding parts of modified virtual model VM1”).

The expression “on the first model” proposed in Patent Owner’s construction is not used in claim 1. Claim 1 Step (A) recites “displaying an image of a first virtual model on a display.” Claim 1 Steps (B) and (D) consistently refer to modification of the first virtual model. Step B recites “at least a portion *of the first virtual model*” is “to be modified.” Step D recites such “modifying” is accomplished “by replacing at least said identified portion *of the first virtual model*.” (emphasis added). Step (B) further recites that the user input is generated by “user interaction with the image on the display.” As the claim language is clear that the user interacts with the image on the display to generate user input identifying a portion of the first virtual model to be modified, we decline as unnecessary Patent Owner’s proposal to construe the claim to mean a “portion on the first virtual model.”

There is also no reason to re-write claim 1 Step (B) to use the expression “that is desired to be replaced,” as proposed by Patent Owner. Claim 1 step (B) recites “identifying at least a portion on the first virtual model that is desired to be modified.” Claim 1 also recites “modifying the first virtual model . . . by replacing at least said identified portion” in Step (D), i.e., a step that is separate and distinct from “receiving user input identifying a portion of the first virtual model” in Step (B). As claim 1 Step (D) limits the “modifying” to “replacing,” there is no reason to incorporate “replacing” into Step (B).

Patent Owner’s proposed construction is also inconsistent with the scope of claim 1. Step (C) of claim 1 recites “receiving a second virtual model of the physical structure . . . generated from a second 3D scan of the physical structure.” Step (C) of claim 1 does not limit the second 3D scan to the claimed “portion of the first virtual model that is desired to be modified” in Step (B). The recitation in Step (D) of “replacing *at least* said identified portion” encompasses replacing more than the identified portion, e.g., replacing the entire first virtual model with the second virtual model from Step (C) in claim 1. Moreover, the “modifying” in claim 1 is distinguished from that in claim 5 in several ways. In claim 5, which depends from claims 4, 3, and 1, the second virtual model is differentiated as limited to a “3D model representative of a second physical part of said physical structure.” As discussed further below in Section V.D concerning the construction of “replacing,” claim 5 also recites “causing the computer system to at least one of delete, remove or replace said identified portions of the first virtual model.” Claim 1 is necessarily broader than dependent claims 3–5 and must be construed as broadly enough to encompass the subject matter of the dependent claims. 35 U.S.C. § 112, fourth paragraph. Because dependent

claim 5 encompasses deleting, removing, or replacing the identified portions, we do not interpret claim 1 as limited to replacing such portions.

For the reasons discussed above, we decline to decline to construe the “Identifying Term,” as proposed by Patent Owner. Instead, recognizing that the words of the Step (B) and Step (D) provide the necessary context, we construe “input identifying” in Step (B) to mean information in any form that specifies a portion of the first virtual model.

D. Replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model.

Petitioner refers to the expression “replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model” as the “Replacing Term.” Pet. Reply. 2. Neither party proposed a construction of the Replacing Term prior to institution.

Without proposing an express construction of the Replacing Term, Patent Owner argues we should adopt its “proposed construction that replacing a portion of a first virtual model with a corresponding portion of a second virtual model involves deleting or removing a portion of the first virtual model and replacing it with a portion of the second virtual model.” PO Resp. 32. Petitioner replies that “the intrinsic evidence demonstrates that ‘replacing’ in the ’192 patent carries its plain and ordinary meaning and is not limited to *requiring* deleting or removing.” Pet. Reply. 5.

In support of its construction, Petitioner argues that claim 5 recites steps (C) and (D) comprise “causing the computer system to at least one of delete, remove or replace said identified portion,” demonstrating that “replacing,” “deleting,” and “removing” are alternatives, not intrinsic requirements of the Replacing Term of claim 1. *Id.* at 4. Petitioner further notes that the ’192 patent describes “deleting” as an alternative to removal or

replacement where it states “part of the first virtual model VM1 is ‘deleted’ or *otherwise* removed or replaced on the display by the user.” *Id.* at 4 (citing Ex. 1001, 21:1–3, 24:19–21). According to Petitioner, the word “otherwise” is “significant because it requires that replacement include a type of virtual model modification that is distinct from deletion.” *Id.*

We are persuaded by Petitioner’s arguments. As discussed above, claim 1 Step (B) recites “modifying the first virtual model,” and Step (D) recites “replacing at least a portion of the first virtual model.” Claim 5 recites deleting and removing the identified portion as alternatives to replacing the identified portion, i.e., “causing the computer system to *at least one of* delete, remove, *or* replace.” Ex. 1001, claim 5 (emphasis added). Similarly, the Specification repeatedly describes delete, remove and replace as alternatives. *See, e.g.*, Ex. 1001, 18:58–60, 18:65, 21:1–45. For example, the Specification states:

The deletion, removal or replacement of part DVM1 is responsive to the application of a special corresponding computer-implemented function (i.e. a corresponding deletion function, removal function or replacement function) via the computer system 32. The special computer-implemented function is, for ease of reference referred to herein as the “delete” function (and includes at least one of a remove function, remove command, delete command, replace command, or replace function) of the computer system 32, and operates to modify for example the first virtual model VM1 by at least one of deleting, removing or replacing a part thereof when “delete” function is activated, i.e., when the “delete” function is applied to the marked area of the image DI1.

Id. at 21:6–19; *see also id.* at 22:34–39 (stating “the part of DVM1 that was previously deleted/removed is at least partially replaced”); *id.* at 24:34–36 (stating “the part DVM1 that was previously deleted/removed is at least partially replaced with a corresponding part of the second 3D virtual model

VM2.’). Thus, claim 5 and the above-quoted Specification passages demonstrate that “delete,” “remove,” and “replace” are distinct steps, thus refuting Patent Owner’s contention that “replacing” requires deleting or removing.

More specifically, in view of the language of claim 5, which lists “delete, remove, or replace,” as distinct alternatives, we consider the meaning of “replacing” in claim 1 as distinct from the meaning of “deleting” or “removing.” “Deleting” and “removing” part of a model do not require addition of new model data. “Replacing” part of a model requires substituting new model data in place of that part of the model being modified. One way to accomplish such replacement is for the user or the computer first to delete or remove the relevant part of the model and then insert the new data, e.g., data from another scan. Ex. 1001, 22:34–39. The ’192 patent discloses other approaches that do not require deleting or removing part of the model. One such approach is described as “a unified replacement function” in which part of a model is replaced “in one operation.” *Id.* at 24:36–39. Another such approach is shown in Figure 9, which describes a sequence of steps that includes as Step 460’

Causing the computer system to modify the first virtual model, to delete or remove or replace a first virtual model part of the first 3D virtual model corresponding to the first image portion by applying a corresponding function (i.e., a delete function or a remove function or a replace function) to the first image portion via interaction with said first image on said display, to provide a modified first 3D virtual model, and *concurrently or subsequently replacing said first virtual model part with a corresponding part of said second 3D virtual model* to provide a composite third 3D virtual model.

Id., Fig. 9 (emphasis added). Figure 9 articulates a separate “delete function” “remove function,” and “replace function” as indicated by the

alternative term “or” and describes “concurrently or subsequently replacing” the first virtual model part with a corresponding part of second 3D virtual model. Although the ’192 patent does not provide details of its unified replacement function or concurrently replacing the first virtual model part with a second virtual model part, Petitioner notes that overwriting existing data of a portion of a model with new data effectively replaces the original data for that portion of the model undergoing replacement. *See*, Hr’g Tr. 13:18–14:2.

In view of (i) its disclosure of a “unified replacement” function performed in “one operation” (Ex. 1001, 24:36–39), (ii) its “for ease of reference” description of the computer’s “delete” function as including alternative commands and functions, i.e. “at least one of a remove function, remove command, delete command, replace command or command function” (*id.* 21:11–19), (iii) its description in Figure 9 of a “remove function *or* a delete function *or* a replace function” (emphasis added) as alternative functions, and (iv) Figure 9’s further articulation of “*concurrently or subsequently replacing* said first virtual model part with a corresponding part of said second 3D virtual mode,” (emphasis added), we decline to construe “replacing” in claim 1 as requiring the user or the computer delete a portion of the model and insert a second model, as urged by Patent Owner. PO Resp. 30. We find “replacing” requires that new data be substituted for the original data in the portion of the model undergoing replacement, but it does not require the sequence of deleting and inserting as argued by Patent Owner.

VI. ANALYSIS OF PRIOR ART CHALLENGES

A. Claims 1–5, 8–13, 15–23, 25–32 As Obvious Under 35 U.S.C. § 103 over Paley and Kriveshko

1. Introduction

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to Patent Owner. See *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

As set forth in 35 U.S.C. § 103(a),

[a] patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Additionally, the obviousness inquiry typically requires an analysis of “whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (requiring “articulated

reasoning with some rational underpinning to support the legal conclusion of obviousness”)); *see In re Warsaw Orthopedic, Inc.*, 832 F.3d 1327, 1333 (Fed. Cir. 2016) (citing *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1360 (Fed. Cir. 2006)).

In the '192 patent, independent claim 1 is drawn to a method, independent claim 28 is drawn to an apparatus, and independent claim 30 is drawn to a non-transitory computer readable medium having a program stored thereon are of similar scope. As claim 1 is illustrative of all the independent claims, our analysis of claim 1 is applicable to independent claims 28 and 30, as well.

2. *Paley*

By way of background, Paley discloses a scanning process that includes the steps of incremental data capture, incremental derivation of three dimensional data and registration of the incremental data to a common coordinate system that brings the data together into a single three-dimensional model of a scan subject. Ex. 1006 ¶ 6. Paley further discloses that “[c]urrent techniques generally separate acquisition from registration, with registration being performed in a separate post-processing step separate from data acquisition.” *Id.* ¶ 7. According to Paley, this approach is disadvantageous because accuracy and completeness of the scan cannot be evaluated until after the scan is complete. *Id.*

In Figure 5, Paley shows a visual interface in which model errors, such as incomplete or inaccurate scan data, are recognized so that a user can return to the data acquisition or scanning mode of Figure 4 either automatically or manually to acquire additional data using, e.g., the scanning hardware in Figure 1. *See*, Ex. 1006 ¶¶ 58–60. Paley notes that in a continuous or incremental data acquisition system the fitting or stitch

between two frames may fail. *Id.* ¶ 38. Paley describes a recovery mode in which the system seeks to reacquire a previous scan by test fitting new scan data to previously acquired data and providing visual feedback to the user to assist in navigating back to a scan location where re-acquisition is being attempted. *Id.* Paley also discloses a related “landing mode” in which a user may attempt to initiate a new scan, registered to or connected to an existing 3D model, using similar visual feedback that notifies the user where the scan has been reacquired. *Id.* Paley incorporates Kriveshko by reference, as disclosing techniques to acquire such data and incorporate it into the model. *Id.* ¶¶ 60, 73, 77 (citing U.S. Application No. 11/337,182, filed Jan. 20, 2006 and noting that a user control may permit a user to return to data acquisition to acquire additional data at a specific point of a digital model where a void or deviation is detected automatically or by the user’s visual inspection of the model).

Although Paley discloses visual feedback techniques in the context of continuous scanning in dental applications, it is not limited to the dental field or continuous scanning and can be used with any imaging technology capable of capturing three dimensional data with suitable precision. *Id.* ¶ 21.

3. *Kriveshko*

Kriveshko discloses a scanning system that acquires three-dimensional images as an incremental series of three-dimensional data sets and tests for successful incremental fits of the data in real time. Ex. 1007, Abstract. Noting that, except for the first frame in a sequence, a reference frame is always available, Kriveshko discloses “the incremental three-dimensional image data may be fitted or stitched to the existing three-dimension model.” *Id.* ¶¶ 65–66. Kriveshko provides visual user cues and

modifies the process depending upon the relationship of newly acquired data to previously acquired data. *Id.*

Kriveshko describes two operating modes; (i) acquisition mode (normal acquisition) and (ii) recover mode. Ex. 1007 ¶¶ 58–59, 75. In normal acquisition mode a scanner passed over a surface acquires and forwards two dimensional image sets to a computer that derives three-dimensional point clouds. *Id.* ¶ 58. “The three-dimensional data for each newly acquired two-dimensional image set may be derived and fitted or ‘stitched’ to existing three-dimensional data using a number of different techniques.” *Id.*, *see also, id.* ¶¶ 60–72.

The system enters recover mode when an image set cannot be fit to the three-dimensional surface data. *Id.* ¶ 59. Recover mode may include acquiring at least one subsequent three-dimensional image and test fitting it to one or more of the sequences of three-dimensional images. *Id.* ¶¶ 9, 59. Recover mode may be entered manually or automatically in response to detection of a lost acquisition. *Id.* ¶ 10.

Kriveshko discloses a stitch recover mode and a related landing mode. *Id.* ¶ 59. Kriveshko enters the “stitch recover” mode when the computer is unable to fit or stitch an existing three-dimensional data set to newly acquired data. *Id.* ¶¶ 58–59, 74. In the recover (or landing) mode, the computer may remove or stop rendering the three-dimensional model, alerting the user to an error. *Id.* ¶ 76. Kriveshko states:

newly derived three-dimensional data may be fitted to three-dimensional data previously derived in the recover mode. In this manner, a new three-dimensional model may be created within the recover mode. When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a

transformation based upon the successfully fitted frames or three-dimensional images.

Ex. 1007 ¶ 86.

4. *Claim 1 – Preamble*

The preamble of claim 1 recites a method of generating a modified virtual model of a physical structure. Petitioner cites Paley as directed to an image capture system that acquires 3D data of a physical structure, resulting in a virtual model of that physical structure. Pet. 14. Patent Owner does not dispute Petitioner’s contentions concerning the preamble of claim 1. *See* PO Resp. 13–15. Based on the evidence of record we agree with Petitioner that Paley discloses the subject matter in the preamble of claim 1.

5. *Claim Limitation 1.1*

Petitioner identifies as claim limitation 1.1 the limitation that recites “(A) displaying an image of a first virtual model on a display operatively connected to a computer system, wherein the first virtual model is generated from first 3D scan data of the physical structure, and wherein said first virtual model fails to properly represent a first physical part of the physical structure.” Pet. 15. Petitioner cites Paley as disclosing “displaying an image of a first virtual model.” *Id.* at 15–16 (citing the two-dimensionally rendered perspective view in Figure 5 as the claimed image and the digital surface representation as the claimed virtual mode). Figure 5 of Paley is reproduced below.

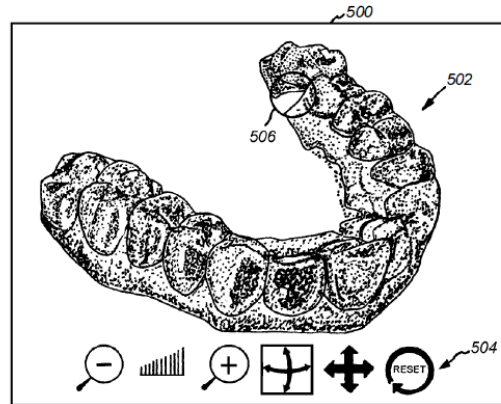


Fig. 5

Figure 5 of Paley depicts a two-dimensional perspective view rendering of a stored digital surface representation 502 based upon a display of discrete surface points. Paley ¶¶ 58, 61. Paley also states that other rendering techniques may be used. Ex. 1006 ¶ 61.

Petitioner further states that the dental image capture system in Figure 1 and the accompanying text of Paley illustrates that the first virtual model is generated from first 3D scan data. *Id.* at 16–17 (citing Ex. 1006 ¶¶ 29, 28). Figure 1 of Paley is reproduced below.

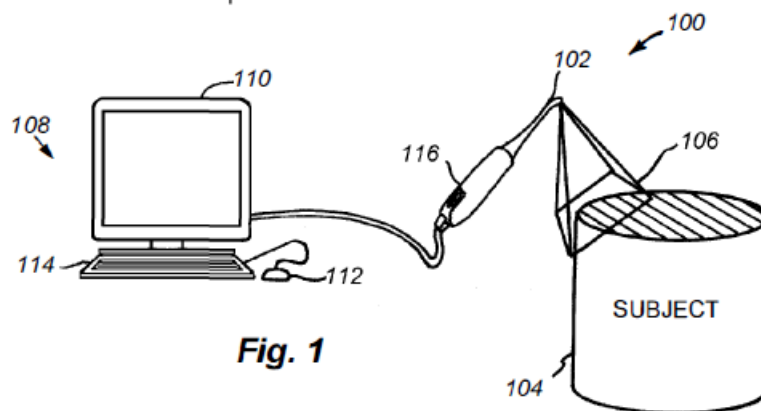


Fig. 1

Figure 1 shows Paley's image capture system 100 includes a processor or computer 108, scanner 102 and subject 104, which may be one or more teeth, dental prostheses, or dental models. Ex. 1006, Fig. 1, ¶¶ 28–29, 32.

Noting that Paley’s description of Figure 5 refers to “errors in a digital model, such as a region 506 of omitted or missing scan data,” Petitioner asserts Paley discloses the portion of limitation 1.1 that recites “wherein said first virtual model fails to properly represent a first physical part of the physical structure.” Pet. 16–17 (citing Ex. 1006 ¶ 59). The Patent Owner Response does not dispute that Paley discloses claim limitation 1.1.

Based on the evidence of record, we are persuaded Petitioner has demonstrated that Paley discloses “displaying an image of a first virtual model on a display operatively connected to a computer system, wherein the first virtual model is generated from first 3D scan data of the physical structure, and wherein said first virtual model fails to properly represent a first physical part of the physical structure,” as recited in claim limitation 1.1.

6. *Claim Limitation 1.2*

Petitioner identifies as claim limitation 1.2 the limitation that recites “(B) receiving user input identifying at least a portion of the first virtual model that is desired to be modified, wherein the user input is generated by user interaction with the image on the display.” Pet. 18. As to this claim element, Petitioner cites region 506 of Figure 5 of Paley as illustrating a portion of the first virtual model to be modified and Paley’s disclosure of a control that permits a user to select a point on the digital model and return to the scanning mode for data acquisition. *Id.* at 19–20 (citing Ex. 1006 ¶ 60). Petitioner notes that Paley refers to “this user initiated rescan mode” as a “landing mode.” *Id.* at 20 (citing Ex. 1006 ¶ 38).

Patent Owner argues that Paley “does not disclose ‘receiving user input identifying at least a portion of the first virtual model that is desired to be modified’ or ‘receiving a second virtual model of the physical structure

with the computer system, the second virtual model generated from second 3D scan data of the physical structure.” PO Resp. 16. Patent Owner further contends that Paley and Kriveshko fail to disclose “receiving user input identifying at least a portion of the first virtual model that is desired to be modified.” PO Resp. 32, 49–51; PO Surreply 17–18.

According to Patent Owner, because Paley and Kriveshko are primarily concerned with voids from scan data, a user selects an area near a deficiency and not the deficiency itself. *Id.* at 50. Pointing to Figure 5 of Paley, Patent Owner argues that because the portion of the model to be selected is a void where data is missing, the user selects a part of the model near the void to orient the computer to register the new scan data as it comes in and then uses the landing or recovery modes to acquire and incorporate the new scan data to fill the void. *Id.* (citing Ex. 1006, Fig. 5, ¶¶ 60, 73, 77).

Claim 1 recites “input identifying a portion *of the model*” that the user seeks to modify. Ex. 1001, claim 1 (emphasis added). We have construed “input identifying” in Step (B) to mean information in any form that specifies a portion of the first virtual model the input to mean information in any form that specifies a portion of the first virtual model. Such information includes, e.g., a tooth number, a custom designed coordinate system, or physical descriptions that identified the boundaries of the region. *See* Section V.C.

Petitioner provides persuasive argument and evidence that Paley discloses “receiving user input identifying at least a portion of the first virtual model that is desired to be modified, wherein the user input is generated by user interaction with the image on the display,” as recited in claim limitation 1.2. We agree with Petitioner that in Paley, the user identifies a portion of the first virtual model where the model fails to

represent properly a first physical part, in order to acquire missing data, e.g., where a void or deviation is detected. Pet. Reply. 19–20 (citing Pet. 18–20; Ex. 1006, Fig. 5, ¶¶ 38, 53, 60, 73, 77). Petitioner emphasizes that in Paley a user control “may permit a user to select a specific point on the surface of the digital model.” *Id.*, see also Ex. 1006 ¶¶ 70–73, Fig. 8 (describing visualization techniques for model “holes,” i.e., digital surface representations of areas with point density below a specified threshold that are inadequate for fabricating physical dental models or performing dental diagnosis or prosthetic fabrication, and can be selected for additional data acquisition with a user control). Paley describes its embodiments in Figure 2 and Figure 3 as displaying a subject from a scanner’s point of view and notes alternative models may be used including “an interface that renders acquired data from a fixed point of view within a global coordinate system.” Ex. 1006 ¶ 52. Controls allow the user to interact with the model to identify the portion to be modified. *Id.* ¶ 73.

We are not persuaded by Patent Owner’s argument that Paley and Kriveshko are primarily concerned with voids in scan data. PO Surreply 50. Paley and Kriveshko are concerned with correcting defective results—a void is just an example of a defect. See, e.g., Ex. 1006 ¶¶ 7, 55, 59 (“other errors such as excessive variability of surface data may be intrinsically identified by fuzziness or excessive random texture”); Ex. 1007 ¶ 5. Patent Owner argues that “[y]ou can’t have a portion of a model be a void. A void is not a portion of a model. It’s a part of the model that doesn’t exist. You can’t identify it, and it means nothing to delete or remove it in order to replace it.” Hr’g Tr. 37:6–9. We disagree. A “void” or missing data at a portion of the model represents a defect in the model of the physical surface where the data is missing; it is that portion of the model the user seeks to identify.

Therefore, after considering both parties' arguments and evidence, we find that Petitioner has demonstrated Paley discloses "receiving user input identifying at least a portion of the first virtual model that is desired to be modified, wherein the user input is generated by user interaction with the image on the display," as recited in claim limitation 1.2.

7. *Claim Limitation 1.3*

Petitioner identifies as claim limitation 1.3 the limitation that recites "(C) receiving a second virtual model of the physical structure with the computer system, the second virtual model generated from second 3D scan data of the physical structure." Pet. 20. Petitioner cites Paley's "landing mode" as disclosing a return to the scanning mode to reacquire 3D scan data from the physical part to be modified in the model. *Id.* (citing Ex. 1006 ¶ 60). Petitioner acknowledges that Paley is not explicit about the way 3D scan data is reacquired into a data structure and ultimately used to modify the virtual model, but contends that Paley incorporates Kriveshko by reference for the purpose of providing this information. *Id.* at 21.

Petitioner argues two features identified by Kriveshko as a stitch recovery mode and a related user initiated landing mode provide the disclosure not explicit in Paley. *Id.* at 22–23, *see* Ex. 1007 ¶¶ 59, 74, 86, 94, 95, 97. Petitioner cites Kriveshko's "landing mode" (the same term used by Paley) as disclosing that supplemental 3D scan data may be acquired and then assembled into a singular and collected or supplemental three-dimensional model. *Id.* at 22. Petitioner cites the following text from Kriveshko concerning the user activated landing mode:

In other embodiments, a landing mode may be provided in which a user attempts to initiate a new scan registered or connected to an existing three-dimensional model. In the landing mode, the system may optionally create a supplemental

three-dimensional model by fitting sequential frames to one another before a successful fit to the original three-dimensional model. In various embodiments, the landing mode may also be distinguished by a user's ability to select a point on the original three-dimensional model for re-acquisition of a scan.

Pet. 22–23; Ex. 1007 ¶ 97.

Petitioner also cites Kriveshko's disclosure of a stitch recover mode. *Id.* at 23 (citing Ex. 1007 ¶ 74).

Patent Owner argues the combination of Paley and Kriveshko fails to disclose claim limitation 1.3. PO Resp. 51. According to Patent Owner, "Paley's computer system receives scan image data from Paley's scanner—not a second virtual model." *Id.* (citing Ex. 1006 ¶¶ 34–36; Ex. 2011, Declaration of Dr. Chandrajit L. Bajaj In Support of Patent Owner's Response ("Bajaj Resp. Decl.") ¶ 79; Ex. 2007, September 30, 2019 Transcript of Deposition of Dr. Eli Saber ("Saber Tr. II"), 54:12–60:3).

Petitioner replies to Patent Owner's arguments by noting that claim limitation 1.3 recites "receiving a second virtual model of the physical structure *with* the computer system." Pet. Reply 21. Petitioner emphasizes that claim limitation 1.3 is not limited to receiving the second virtual model at any particular interface and does not exclude further processing by the computer system to arrive at the second virtual model. *Id.* Petitioner argues that in Paley and the '192 patent, it is the computer system that provides the second virtual model and that Patent Owner's experts agree. Pet. Reply 21–22 (citing Ex. 1015, Transcript of Deposition of Dr. Chandrajit L. Bajaj ("Bajaj Tr.") 164:9–165:15 for the proposition that Figure 9 of the '192 patent discloses the step of receiving the second virtual model is done with the computer system; Ex. 1013, Transcript of Deposition of Dr. Maureen

Valley (“Valley Tr.”), 100:2–21 as explaining that in the ’192 patent the computer displays the first virtual model).

We find as follows regarding claim limitation 1.3. The ’192 patent states that “any suitable scanner . . . is used by the practitioner to acquire the 3D data” that is used to generate the models. Ex. 1001, 18:5–13; *see also*, *id.* at 21:56–22:12 (describing steps in generating second virtual model VM2 and noting that the scanning procedure includes scanning the additional part P2 of the real dental surface in proximity to part DRM1, a real dental surface that failed to be clearly represented in first virtual model VM1). Paley discloses scanning includes incremental data capture, incremental derivation of three-dimensional data, and registration of the incremental data to a common coordinate system in which “[t]he final registration step brings incremental data together into a single three dimensional model of a scan subject.” Ex. 1006 ¶ 6. As discussed above, Petitioner explains how Kriveshko processes scanned data to develop a second model that is fit to the first model. Pet. 22 (citing Ex. 1007 ¶ 97 (disclosing “creating a supplemental model by fitting sequential frames to one another before a successful fit to the original three-dimensional model.”). Kriveshko discloses two-dimensional image sets acquired by a scanner may be used by a computer to derive three-dimensional point clouds that may be fitted or stitched to existing three-dimensional data. Ex. 1007 ¶ 58. When such fitting fails, the system test fits new scan data to previously acquired data to reacquire or resume the scan. *Id.* ¶¶ 59, 74. The stitch recovery process may also begin assembling a new three-dimensional model from sequential, incremental three-dimensional data sets. *Id.* ¶ 74. If the original scan is reacquired with a successful fit to the original three dimensional model, all of the three-dimensional data acquired during stitch recovery may be

immediately registered to the original three-dimensional model. *Id.* Thus, we find Petitioner’s arguments that the combination of Paley and Kriveshko disclose “receiving a second virtual model of the physical structure with the computer system, the second virtual model generated from second 3D scan data of the physical structure,” as recited in claim limitation 1.3 are persuasive.

8. *Claim Limitation 1.4*

Petitioner identifies as claim limitation 1.4 the limitation that recites “(D) modifying the first virtual model with the computer system by replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model, thereby generating the modified virtual model.” Pet. 24. Petitioner contends that Kriveshko discloses this feature in two ways: (i) three-dimensional data acquired during landing mode to form a supplemental three dimensional model may be registered with an original model and (ii) “all of the three dimensional data acquired during the [stitch] recover mode may immediately be registered to the original three-dimensional model” once the original scan is reacquired with a successful fit. *Id.* at 24–26 (quoting Ex. 1007 ¶ 74 and citing Ex. 1007 ¶¶ 59, 77–79, 86, 97).

Patent Owner contends the combination of Paley, as modified by Kriveshko, “fails to disclose modifying the first virtual model by replacing at least a portion the model identified by the user, e.g. the point selected by the user, with a corresponding portion of another model, e.g. a corresponding point on another model.” PO Resp. 35 (citing Ex. 2011, Bajaj Response Decl. ¶¶ 107–118). According to Patent Owner, Paley and Kriveshko teach adding new scan data to an existing model, but not

replacing a portion of a virtual model with a portion of a second virtual model. *Id.* at 35.

Patent Owner argues that in Kriveshko “[w]here a rescan occurs in order to address suspected inaccurate or deficient data, landing mode allows a user to fill the void by adding remedial data to the 3D data set and update the model.” PO Resp. 22 (citing Ex. 2011, Bajaj Resp. Decl. ¶¶ 95–96). Patent Owner argues in the case of a stitching failure, a second virtual model is generated because the computer is unable to register all the 3D data to a single model, and “[t]he second virtual model is therefore wholesale incorporated into the first virtual model upon a successful test fit.” *Id.* According to Patent Owner, “[n]o portion of the first virtual model is selected, deleted, removed or replaced with any portion of the second virtual model” and “[n]o underlying data is deleted, removed, or replaced with new data.” *Id.*

Characterizing Paley and Kriveshko both as generating a 3D virtual model by compiling multiple scans, Patent Owner notes that when an operator moves outside the proper scanning distance, scan data registration and image stitching fail. *Id.* at 35 (citing Ex. 1006 ¶ 43). Upon recognizing such failure, the practitioner can rescan the area of concern in either stitch recover mode or in landing mode, as taught by Kriveshko. *Id.* (citing Ex. 1007 ¶¶ 75–76). Patent Owner summarizes Petitioner’s arguments concerning Kriveshko as follows: in “landing mode” supplemental 3D scan data of the physical structure may be acquired, assembled into a singular and collected “second virtual model” or “supplemental three-dimensional model” and “registered” with an “original three-dimensional model” or “first virtual model,” resulting in a “modified virtual model.” *Id.* (citing Pet. 24–25).

According to Patent Owner, “Kriveshko’s second virtual model does not *replace* a portion the first virtual model.” Instead, Kriveshko generates a second virtual model when the computer has insufficient information to register the rescanned data to the original model; but once the computer has sufficient information to fit the two models together, all the scan data is registered to the original virtual model. *Id.* at 36 (citing Ex. 1007 ¶¶ 59, 74). Thus, according to Patent Owner “[t]he user does not select a portion of the first virtual model to be *replaced* with a portion of the second virtual model. Rather, the scan data *underlying* the second virtual model is merely incorporated wholesale into the 3D point cloud of the original virtual model immediately upon a successful fit.” *Id.*

Patent Owner expands its discussion of the replacement function in its discussion of claim element 5.1, which differs from claim element 1.4 by its recitation of “causing the computer system to at least one of delete, remove or replace.” PO Resp. 52–55. Patent Owner argues that the combination of Paley and Kriveshko does not provide the user appropriate controls to delete, remove or replace a portion of the virtual model, but only to obtain additional data, as opposed to replacement data. PO Resp. 52. Patent Owner contends the illumination function Paley, as shown in Figure 9 of Paley in the form of a flashlight visualization, exists merely “to assist the user to navigate to a point of rescan” and “nothing in the model is deleted, removed or replaced.” *Id.* at 54.

Patent Owner further argues Petitioner’s expert, Dr. Saber, acknowledges Kriveshko “does not require deletion” of underlying data of the first virtual model to achieve registration. PO Resp. 39 (citing Ex. 2007, Saber Tr. II 124:6–126:16, 118:4–14, 122:9–126:16); *see id.* at 42 (citing Ex. 2011, Bajaj Decl. ¶ 117).

Petitioner replies that Patent Owner's argument is irrelevant to the claims (i) because "replacing" does not require deleting or removing and (ii) because Patent Owner's arguments that the prior art's second virtual model is limited as it is generated only when the computer does not have sufficient information to register rescanned data to the original model "are directly contrary to the actual statements in Kriveshko." Pet. Reply 11.

Petitioner argues "replacing the inaccurate scan data in Paley's model with Kriveshko's supplemental model does not require deletion (the supplemental model may simply be stitched over the inaccurate data to hide the inaccurate data), and in doing so the 'replacing' claim language of the independent claims is met." *Id.* at 17; *see also, id.* at 14 (discussing Dr. Saber's testimony and explaining that "a person of ordinary skill would have understood that 'replacing' simply requires that the original data be replaced by new data." (citing Pet. 17–18; Ex. 1006 ¶ 59)).

We agree with Petitioner that the replacing term as used in the '192 patent to include replacement "in one operation" does not require removing or deleting. *See* Ex. 1001, 24:34–39. Our construction of "replacing" does not require deleting as a separate step. *See* Section V.D above.

As we agree that it is not necessary for Petitioner to demonstrate the references show deleting as a separate step, we turn our attention to whether Paley and Kriveshko teach the replacing step recited in step 1.4. We are persuaded by the following arguments and evidence presented by Petitioner. In support of its position that Patent Owner's arguments concerning replacing are contrary to Kriveshko, Petitioner emphasizes that Kriveshko

explain[s] the existence of a separate second virtual model, which when complete, is used to modify the first virtual model by replacement. *See* Pet., 22–23 (citing Ex.1007, ¶ 97 (citation not acknowledged by PO) ("In the landing mode, the system

may optionally create a supplemental three-dimensional model by fitting sequential frames to one another before a successful fit to the original three dimensional model.”).

Pet. Reply 11–12. Petitioner quotes Kriveshko’s disclosure that

the process may optionally begin assembling a new three-dimensional model from sequential, incremental three-dimensional data sets. In this manner, once the original scan is reacquired with a successful fit to the original three-dimensional model, all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model.

Id. at 12 (quoting Ex. 1007 ¶ 74)(emphasis by Petitioner).

Petitioner’s citation to paragraph 74 concerns the stitch recover mode in which the process “may attempt to reacquire a scan or resume a scan by test fitting newly acquired data set to some portion of the three-dimensional model.” Ex. 1007 ¶ 74. We find that Kriveshko’s reference to test fitting the newly acquired data to “some portion of the three dimensional model” indicates that the test fitting can be at a location on the model, e.g., any location on the model where the user observes erroneous or unusable data.

The issue before us is whether Paley and Kriveshko teach modifying a model by replacing a portion of the model with a portion of a second model, e.g., by entering a recover mode after determining the 2D scan has not been successfully converted into a 3D point cloud. To that end, Paley explains that its Figure 5 illustrates an “evaluation mode” in which a model containing errors is corrected using reacquisition techniques taught by (and incorporated by reference to) Kriveshko. Ex. 1006, Figure 5, ¶¶ 53, 58–60.

Consistent with Petitioner’s arguments, Figure 5 of Paley illustrates a user interface in an “evaluation mode” showing a location on the model where the user display indicates errors exist. Ex. 1006 ¶¶ 54, 59. The errors may be voids in the model where data is missing or “[o]ther errors such as

excessive variability of surface data” that “may be identified by fuzziness or excessive random texture.” *Id.* ¶ 59. Paley discloses that visualization of scan quality may be augmented by explicit indicators, such as coloring or shading that “visually indicate regions of incomplete scan data, inaccurate scan data, insufficient detail (such as where a restoration may be fixed) and the like.” *Id.* Navigation controls allow the user to rotate, pan, zoom in or otherwise navigate around the digital model to more closely inspect areas of interest to

permit a user return to data acquisition, e.g., the scanning mode of Fig. 4, to acquire additional data where a void or deviation is detected” by “select[ing] a specific point on the surface of the digital model . . . where the continuous scan is to be reacquired from the subject as described in [Kriveshko].

Id. ¶ 60; *see also, id.* ¶ 73 (describing the same technique for locating areas of low data density for scan reacquisition), *id.* ¶ 77 (describing the same technique in relation to an illumination beam to provide a user visual feedback for locating areas for scan reacquisition).

Patent Owner argues that Paley’s superimposition of a visual effect does not involve a process of test fitting or registrations in which a virtual model is being manipulated. PO Resp. 7 (citing Ex. 1006 ¶ 75; Ex. 2011). As discussed above, Paley discloses superimposing a visual effect to aid the user in positioning the scanning device and using the scanning techniques disclosed by Kriveshko to acquire and fit the data, i.e., the data that replaces the inaccurate data at the locations where the user observed a void or deviation, as highlighted by the visual effect. Ex. 1006 ¶¶ 60, 73, 77.

Patent Owner argues that where “inaccuracies,” such as areas of low data density or voids appear in the virtual model, Paley and Kriveshko remedy these inaccuracies by reacquiring and adding additional data, as

opposed to replacing a portion of the model with a second model. PO Surreply 15. Patent Owner's arguments are not persuasive in light of the discussion in paragraph 97 of Kriveshko. Although Kriveshko does not state explicitly that the modification involves "replacing" subject matter previously incorporated into the model, paragraph 97 of Kriveshko, cited by Petitioner, describes the landing mode as one in which the system may "create a supplemental 3D model by fitting sequential frames into one another before successfully fitting to the original 3D model." Ex. 1007 ¶ 97. Kriveshko explicitly states "in various embodiments the landing mode may be distinguished by a user's ability to select a point on the original three-dimensional model for re-acquisition of a scan." *Id.* Kriveshko's description of these landing mode embodiments indicates the landing mode is employed to reacquire a scan that failed while creating the original model. Although Kriveshko does not refer explicitly to replacing existing subject matter in the original or first model, Kriveshko teaches reacquiring a scan at a point on a model, obtaining new scan data, creating a supplemental 3D model and subsequently fitting the supplemental model data into the original model, i.e., substituting the supplemental model for the defective portion of the first model. *Id.* Thus, Kriveshko discloses techniques for replacing model data at a location on the model selected by the user. Paley teaches visual aids that assist the user in specifying the location on the model where errors in the model require the data be replaced.

In consideration of the above, we find Petitioner has demonstrated that the combination of Paley and Kriveshko discloses the features recited in claim limitation 1.4.

We further agree with Petitioner, that even if the replacing step is construed to require deleting the inaccurate data, Petitioner has shown that

such deleting was well known and would have been obvious to a person of ordinary skill in the art. Pet. Reply 15–16 (citing Ex. 2007). We address deletion in more detail in our analysis of claim 5, which explicitly recites deletion as one alternative to replacement. *See* Section VI.A.10 below.

9. *Claims 2–4*

Claim 2 depends from claim 1 and recites the “physical structure comprises any one of an intraoral cavity of a patient or a physical dental model representative of said intra-oral cavity.” As Petitioner notes, Paley discloses inserting a scanner into a patient’s mouth and acquiring data from a dental model. Pet. 26 (citing Ex. 1006 ¶ 30). Patent Owner does not dispute that Paley discloses this limitation. We find that Petitioner has demonstrated Paley discloses this limitation.

Claim 3 depends from claim 1 and recites “the first virtual model includes a first 3D virtual model representative of said first physical part of the physical structure, and step (A) comprises receiving said first 3D virtual model at the computer system and displaying on said display a first display image corresponding to said first 3D virtual model.” Petitioner cites Figure 5 of Paley and the corresponding description as disclosing this limitation. Pet. 27–28 (citing Ex. 1006, Fig. 6, ¶ 58; Ex. 1010, Saber Decl. ¶¶ 84–86).

Citing its discussion of claim limitation 1.3, Patent Owner contends that the combination of Paley and Kriveshko fail to teach the similar limitation of claim 3. PO Resp. 56. Patent Owner contends that Petitioner’s expert acknowledged the virtual model is received from Paley’s scanner, but instead Paley’s computer system receives scan image data, rather a virtual model. *Id.* (citing Ex. 1006 ¶¶ 34–36; Ex. 2011, Bajaj Resp. Dec. ¶ 131).

We addressed the parties' arguments directed to this issue in our discussion of claim limitation 1.3 and found the combined teachings of Paley and Kriveshko supports Petitioner's position. For the same reasons, we find Petitioner has demonstrated that the combination of Paley and Kriveshko discloses the limitations recited in claim 3.

Claim 4 depends from claim 3 and recites "step (B) comprises receiving user input identifying on said first display image at least a first display image portion thereof generated by user interaction with said display, said first display image portion corresponding to said identified portion of the first virtual model, and said identified portion of the first virtual model being representative of a first physical portion of said first physical part." Petitioner again cites Figure 5 of Paley, arguing that the claimed identified portion of the first virtual model, i.e., region 506 in Figure 5, selected by the user for correction "is representative of a first physical portion of said first physical part (i.e. a physical sub-part of the actual physical part of the full arch of the patient that is not represented properly in the illustrated virtual model)." Pet. 30–31. Patent Owner does not dispute that Paley discloses the limitation of claim 4. We find that Petitioner has demonstrated Paley discloses this limitation.

10. Claim 5

Claim 5 depends from claim 1 and recites that steps (C) and (D) comprise limitations subsequent to Step (B) that Petitioner identifies as limitations 5.1 through 5.4.

a) [5.1]: causing the computer system to at least one of delete, remove or replace said identified portion of the first virtual model by applying a corresponding function to said first display image portion via interaction with

said first display image on said display, to provide a modified first 3D virtual model

As discussed above, we find that the combination of Paley and Kriveshko discloses the replacing step of claim limitation 1.4. *See* Section VI.A.8. Claim limitation 5.1 includes replacing as an alternative (“at least one of delete, remove or replace”); therefore we find Paley and Kriveshko disclose this element of claim limitation 5.1(a). Petitioner cites Figure 9 and the corresponding discussion in Paley as evidence that Paley and Kriveshko teach “applying a corresponding function to said first display image portion via interaction with said first display image on said display.” Pet. 31–32.

Patent Owner argues that Petitioner fails to show how Paley and Kriveshko disclose the claimed removing, deleting, or replacing is done “by applying a corresponding function to said first display image portion via interaction with said first display image on said display, to provide a modified first 3D virtual model.” PO Resp. 53. We address the interaction with the display feature by way of the illumination function in Figure 9 of Paley in our discussion of claim limitation 1.4. *See* Section VI.A.8 above. Figure 9 depicts a visual technique using a simulated external visualization beam, such as a flashlight or spotlight, to localize scanner 908 with respect to the underlying physical model and serve as a navigation tool during a scan by providing visual feedback. Ex. 1006 ¶¶ 74–76. The illuminated region may correspond to a region from which data is being acquired. *Id.* ¶ 76. We also extensively discussed the “replacing” function in our analysis of claim limitation 1.4 (Step D). *See* Section VI.A.8 above. Thus, we agree with Petitioner that Paley and Kriveshko disclose “applying a corresponding function to said first display image portion via interaction with said first display image on said display.”

In arguing that Petitioner fails to show where the computer function limitation appears in the prior art, Patent Owner reiterates its arguments (i) that neither Paley nor Kriveshko expressly describes deleting, removing or replacing, (ii) that such actions are not necessary for Kriveshko's final registration step, and (iii) that the visual cue in Paley is a dynamic object on the display screen, separate from the model, to indicate where additional scan data is acquired, but does not delete, remove, or replace any subject matter. PO Resp. 53–55. We discuss Patent Owner's arguments extensively in our analysis of claim 1, particularly in the context of "replacing at least said identified portion of the first virtual model" (claim limitation 1.4). *See* Section VI.A.1.2–1.4. For the same reasons, we find that Paley and Kriveshko teach at least the "replacing" alternative of claim limitation 5.1.

Petitioner's also argues that the combination of Paley and Kriveshko also teaches the "remove" or "delete" alternatives recited" in claim limitation 5.1. For the reasons discussed below, we also find that the combination of Paley and Kriveshko discloses the deleting and removing alternatives.

Figure 2 of Kriveshko depicts a process for three-dimensional scanning. Ex. 1007 ¶ 60. After acquiring an image and converting 2D scan data to a 3D point cloud (*id.* ¶¶ 60–63), because of possible errors, step 208 "tests the recovery of incremental data for internal consistency, rather than by comparison to the full three-dimensional model reconstructed from incremental scans" (*id.* ¶ 64). Such errors may result, for example, from "movement or the scanner laterally off the subject may result in an insufficient amount of derived data," or "rapid scanner motion may cause blurring" *Id.* ¶¶ 60–63. If the 2D data has not been converted successfully into 3D data (or if a user purposely interrupts the scan) the process advances

to stitch recover mode where it resumes or reacquires a scan by testing newly acquired data for fit with some portion of the 3D model. *Id.* ¶¶ 64, 73. In the case of resuming a scan interrupted by the user or by the computer, the model is incomplete and, in the absence of rescanning a previously scanned portion of the model, there arguably is no modification of the model by replacing a portion of the model because the newly scanned data is additional data, rather than substitute data.

As Petitioner notes, however, Figures 5 and 9 of Kriveshko concern marking a portion of an existing model, e.g., using the visual cue of Figure 9 to highlight the inadequate portion of the model in Figure 5 to identify the rescan area. Pet. 31–35. Petitioner is correct that Kriveshko not only discloses replacing that portion of the model in the highlighted area with a model generated from the rescan data (a rescan of a second physical part that at least partially overlaps the first physical part), but the registration of the replacement portion also discloses deleting or removing a portion of the model. *Id.* at 34–35. We credit the testimony of Petitioner’s expert, Dr. Saber, who explains that Kriveshko uses a partial overlap test fit method to establish “known-good reference frame data” for its test fitting and that Kriveshko explains to a person of ordinary skill that the data relating to the identified portion of the first virtual model is deleted because it is not needed for the test fitting, and is distorted or missing. *Id.*; Ex. 1010, Saber Decl. ¶ 99 (citing Ex. 1006 ¶ 60 as disclosing engaging the landing mode to correct distorted or missing data; citing Ex. 1007 ¶¶ 68, 74, and 97 as disclosing the use of periphery frames, and a supplemental three-dimensional model registered with the original three dimensional model). According to Dr. Saber, the result of this deletion is a modified first three dimensional model. Ex. 1010 ¶ 99.

We also credit Petitioner's argument and Dr. Saber's testimony that deletion of the underlying data in the first virtual model during landing mode would have been obvious, and there is no technical significance to when the data is deleted before the ultimate registration of the assembled three dimensional model (second virtual model) with the original three-dimensional model. Pet. 35 (citing Ex. 1010, Saber Decl. ¶ 100); *see also* Pet. Reply 14 (citing Ex. 2007, Saber Tr., 51:15–16, 120:11–14), 15 (citing Ex. 1015, Bajaj Tr., 168:3–19, 170:2–172:8 for the proposition that Patent Owner's expert acknowledged deleting data to be replaced was well known; Ex. 2007, Saber Tr., 80:2–4, 82:18–83:13, explaining that deleting inaccurate data from models was well known). We agree with Petitioner that the deleting and removing would have been obvious to a person of ordinary skill given this evidence.

In consideration of the above, we agree with Petitioner that Paley and Kriveshko discloses “causing the computer system to at least one of delete, remove or replace said identified portion of the first virtual model by applying a corresponding function to said first display image portion via interaction with said first display image on said display, to provide a modified first 3D virtual model,” as recited in claim limitation 5.1.

b) [5.2]: receiving the second virtual model in the form of a second 3D virtual model representative of a second physical part of said physical structure, wherein a spatial disposition of said second physical part with respect to said first physical part is known or determinable

Petitioner cites Kriveshko as disclosing that the claimed spatial distribution between the first physical part and the second physical part is determined by testing the fit of the newly acquired data to an existing 3D

model from a 3D scan of the second physical part, e.g., where the second physical part physically overlaps the original physical part. Pet. 37 (citing Ex. 1007 ¶¶ 65–66, 68, 74, 86, 97). Patent Owner does not address claim limitation 5.2 explicitly.

Noting that the goal of Kriveshko’s landing mode is reacquiring data to replace the originally scanned data from the first physical part with data scanned from the second physical part, Petitioner notes that test fitting involves determining the disposition of the second physical part relative to the first physical part by test fitting the newly acquired data to the existing 3D model prior to full registration. *Id.* at 37–38 (citing Ex. 1007 ¶¶ 74, 97; Ex. 1010, Saber Decl. ¶¶ 107-108). As we discussed previously in this Decision, Kriveshko discloses “[i]n the landing mode, the system may optionally create a supplemental three-dimensional model by fitting sequential frames to one another before a successful fit to the original three-dimensional model.” Ex. 1007 ¶ 97. In view of this evidence we find Petitioner has demonstrated the combination of Paley and Kriveshko disclose the features recited in claim limitation 5.2

c) [5.3]: virtually registering said second 3D virtual model with respect to said modified first 3D virtual model to provide said modified virtual model wherein said identified portion of the first virtual model is replaced with a corresponding part of said second 3D virtual model representative of a second physical portion of said second physical part

Petitioner argues that, using terminology similar to that used in Paley, Kriveshko explains that in landing mode supplemental 3D scan data is acquired and collected into a second 3D virtual model, and registered with an original 3D model to produce a modified virtual model. Pet. 38–39 (citing Ex. 1007 ¶ 59 (reacquisition in landing mode), ¶ 97 (discussing

assembly of a supplemental 3D model in landing model), ¶ 74 (discussing fitting and registering a supplemental 3D model to an original 3D model), ¶ 86 (concerning the independent nature of the second virtual model and full registration with the first virtual model); Ex. 1010, Saber Decl. ¶¶ 111–112).

Patent Owner does not address claim limitation 5.3 explicitly. We discuss Paley and Kriveshko’s landing mode in detail above and find that Petitioner has demonstrated the combination of Paley and Kriveshko disclose the features recited in claim limitation 5.3.

d) [5.4]: outputting said modified virtual model from said computer system

Petitioner argues that Paley discloses claim limitation 5.4 because it discloses saving the modified virtual model from its computer system. Pet. 39. Patent Owner does not address claim limitation 5.4 explicitly. We discuss Paley and Kriveshko’s landing mode in detail above and find that Petitioner has demonstrated the combination of Paley and Kriveshko disclose the features recited in claim limitation 5.4.

11. Claims 8–12

Claim 8 depends from claim 5 and recites “said second physical part at least partially overlaps said first physical portion of said first physical part of said physical structure to provide data on said spatial disposition of said second physical part with respect to said first physical part.” Petitioner cites Kriveshko as disclosing “a test fitting process that involves the determination of the disposition of the second physical part with respect to the first physical part when analyzing the overlap between the two, by properly test fitting the newly acquired data to the existing three-dimensional model prior to full registration.” Pet. 39 (citing Ex. 1007 ¶¶ 74, 97). Petitioner further notes that Kriveshko’s test fitting process uses data

on spatial disposition of the second physical part with respect to the first physical part provided in the assembled second 3D virtual model, allowing for successful test fitting with reference frames of previously acquired data from the first physical part.” *Id.* at 40 (citing Ex. 1007 ¶¶ 65–66; Ex. 1010, Saber Decl., ¶¶ 115–116). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 8.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 8.

Claim 9 depends from claim 5 and recites “said second physical portion of said second physical part spatially corresponds to but is topographically different from said first physical portion of said first physical part.” Petitioner contends that all the elements of claim 9 are disclosed by Paley. Pet. 40. Petitioner cites Paley as disclosing the use of a scanning system in an iterative process to prepare a tooth surface by removing tooth material and rescanning at least once, so that a second physical portion of the second physical part spatially corresponds to, but is topographically different from, the first physical portion of the first physical part. Pet. 40–41 (citing Ex. 1006 ¶¶ 62–64; Ex. 1010, Saber Dec. ¶¶ 119–120). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 9.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 9.

Claim 10 depends from claim 5 and recites “corresponding part of said second 3D virtual model spatially corresponds to but is topographically

different from said portion of the first virtual model.” Petitioner argues that Paley discloses preparing a tooth by removing tooth material, such that the second physical portion of the second physical part spatially corresponds to, but is topographically different from the first physical portion of the first physical part. Pet. 41. According to Petitioner, the topological differences will be reflected in the portion of the first virtual model and second 3D virtual model. *Id.* Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 10.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 10.

Claim 11 depends from claim 5 and recites “said first virtual model represents said first physical part of the physical structure, wherein said first virtual model is considered to fail to comply with a predetermined requirement.” Petitioner notes that region 506 of Paley’s Figure 5 fails to properly represent the physical part of the physical structure, and thus represents the claimed first physical part of the physical structure. Pet. 41. As a result, the virtual model is a deficient one that Paley evaluates, e.g., by evaluating for omitted or missing scan data or assessing topology. *Id.* at 42 (citing Ex. 1006 ¶¶ 55–57, 72; Ex. 1010, Saber Decl. ¶ 127). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 11.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 11.

Claim 12 depends from claim 11 and recites “said predetermined requirement comprises providing high surface definition of a surface of

interest in said first physical portion of said first physical part of the physical structure.” Petitioner notes that among Paley’s predetermined requirements is a point density threshold required for providing high surface definition (*i.e.* high quality scanning data) of a surface of interest in the first physical portion of the first physical part of the physical structure. Pet. 42-43 (citing Ex. 1006 ¶¶ 32, 51, 72; Ex. 1010, Saber Decl. ¶¶ 128–129). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 12.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 12.

12. Claim 13

Claim 13 depends from claim 12 and recites “at least a part of said surface of interest in said first physical portion of said first physical part was obscured when the said first 3D virtual model was created, and wherein said second physical portion of said second physical part corresponds to said first physical portion of said first physical part wherein said at least a part of said surface of interest is now obscured.”

Citing paragraph 26 of Paley as stating Paley’s dental objects include dental implants and implant abutments, Petitioner argues that Paley’s scanning and analysis methods apply equally to such implants and their associated abutments. Pet. 43. Petitioner argues a person of ordinary skill would evaluate an implant with its associated abutment using Paley’s method by performing an initial scan with the abutment in place, thus obscuring a portion of the dental implant (the first physical portion of the first physical part). *Id.* (citing Ex. 1006 ¶ 68). Petitioner argues a person of ordinary skill would then remove the abutment and perform a second scan,

such that the portion of the dental implant is no longer obscured and is a second physical portion of the second physical part that corresponds to the first physical portion of the first physical part. *Id.* at 44 (citing Ex. 1006 ¶ 68; Ex. 1010, Saber Decl. ¶ 133)

Patent Owner contends that Petitioner fails to support its assertion that a practitioner would take these actions. PO Resp. 57–58 (citing Pet. 43–44; Ex. 1006 ¶ 68); PO Surreply 21 (arguing Petitioner’s assertion is speculative). Petitioner responds that Patent Owner fails to provide any reasoning why Paley’s disclosure relating to dental implants does not lead a person of ordinary skill to reason as Petitioner argues and the absence of testimony from Petitioner’s dental expert, Dr. Valley, supports Petitioner’s analysis. Pet. Reply 25–26.

We find as follows regarding claim 13. Paragraph 68 of Paley, cited by Petitioner, explains that reviewing a crown surface preparation is only one useful application of Paley’s analysis and vision tool and that the same techniques can be applied to a variety of dental objects, including restorations, hardware, appliances as well and any region of diagnostic or other significance that objectively can be characterized for automated analysis. Ex. 1006 ¶ 68; Ex. 1010, Saber Decl. ¶¶ 131–132. Paley discloses preparing a tooth surface for a crown in paragraphs 63–67, describing “an automated process may examine the surface preparation and surrounding dentition to ensure adequate physical clearance, taper, appropriate shape, and the like for the specific restoration type” (Ex. 1006 ¶ 63), “scanning the tooth surface, and analyzing the tooth surface may be applied iteratively to refine a surface preparation” (*id.* ¶ 65), “specifications for a particular restoration may vary from dentist to dentist, from laboratory to laboratory, from manufacturer to manufacturer, and from tooth to too . . . occlusion and

clearance for incisal tooth surfaces may be analyzed differently from occlusion and clearance for molar occlusal surface” (*id.* ¶ 66). Based on this evidence and the uncontroverted testimony of Petitioner’s expert, we find Petitioner has demonstrated the limitations of claim 13 would have been obvious to a person of ordinary skill.

13. Claims 15–23, 25–32

Claim 15 depends from claim 13 and recites “said first physical portion of said first physical part was obscured with an artifact, and wherein said second physical portion of said second physical part corresponds to said first physical portion of said first physical part wherein said artifact has been removed.” Referencing its discussion of claim 13, Petitioner contends the limitations of claim 15 are disclosed by Paley. Pet. 44. Petitioner notes that Paley discusses a dental implant abutment as an “artifact” and the analysis of a dental implant and its abutment using Paley’s disclosed scanning methods. *Id.* (citing Ex. 1010, Saber Decl. ¶ 134). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 15.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 15.

Claim 16 depends from claim 15 and recites “said artifact comprises an impression abutment or any other structure mounted onto a dental implant that is embedded in said physical structure.” Petitioner cites Paley as disclosing its scanning and analysis method is applicable to hardware such as a dental implant with its associated abutment. Pet. 44 (citing Ex. 1006 ¶ 68). Petitioner notes that in such applications the artifact is an abutment that is a structure mounted onto the dental implant, which itself is embedded

in the patient's jaw bone or physical structure. *Id.* at 44-45 (citing Ex. 1010, Saber Decl. ¶¶ 135–136). Patent Owner does not respond explicitly to Petitioner's arguments concerning the additional limitations recited in claim 16.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 16.

Claim 17 depends from claim 11 and recites “said predetermined requirement comprises providing a surface of interest in said first physical portion of said first physical part of the physical structure that is configured for enabling a prosthesis to be mounted with respect thereto.” Referencing its discussion of claim 11, Petitioner cites Paley as disclosing the use of its scanning system to prepare a tooth surface iteratively by removing tooth material and rescanning the tooth surface at least once. Pet. 45 (citing Ex. 1006 ¶ 65; Ex. 1010, Saber Decl. ¶¶ 137–138). According to Petitioner preparing a tooth surface involves providing a surface of interest in the first physical portion of the first physical part of the physical structure that is configured for enabling a prosthesis to be mounted when the tooth preparation process is complete and the tooth is ready to accept a prosthesis such as a crown. *Id.* (citing Ex. 1006 ¶¶ 62–64; Ex. 1010, Saber Decl. ¶ 139). Patent Owner does not respond explicitly to Petitioner's arguments concerning the additional limitations recited in claim 17.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 17

Claim 18 depends from claim 17 and recites “at least a part of said surface of interest in said first physical portion of said first physical part is

inadequate for enabling a prosthesis to be mounted with respect thereto, and wherein said second physical portion of said second physical part corresponds to said first physical portion of said first physical part wherein said at least a part of said surface of interest has been physically altered.” Petitioner cites Paley as disclosing an iterative tooth surface preparation process in which at least a part of the surface of interest in the first physical portion of the first physical part is inadequate for enabling a prosthesis to be mounted, and would be represented in the first virtual model. Pet. 46 (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶¶ 140–141). Tooth material that would be physically removed during the preparation process, such that the second physical portion of said second physical part corresponds to the first physical portion of the first physical part and wherein said at least a part of said surface of interest has been physically altered, would be represented in the second 3D virtual model. *Id.* (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶ 142). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 18.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 18.

Claim 19 depends from claim 18 and recites “wherein said at least a part of said surface of interest has been physically altered via a material removal operation to modify topology of said at least a part of said surface of interest.” Petitioner cites Paley as disclosing that in its iterative tooth preparation process some tooth material would be physically removed, resulting in a modification of the topography of at least a part of the surface of interest. Pet. 47 (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl.

¶¶ 143–144). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 19.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 19.

Claim 20 depends from claim 19 and recites “at least a part of said surface of interest comprises a finish line of a tooth onto which it is desired to mount the prosthesis, wherein in said first physical portion of said first physical part said finish line is inadequately defined, and wherein in said second physical portion of said second physical part said finish line is adequately defined.” Noting that the ’192 patent defines a “finish line” as the transition boundary between a prosthesis and a dental preparation, Petitioner cites Paley as disclosing an iterative process for tooth preparation and scanning for a crown prosthesis. Pet. 47–48 (citing Ex. 1001, 1:53–56; Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶¶ 145–146). Petitioner further notes that the claimed “first physical portion of said first physical part said finish line [that] is inadequately defined” would be represented by the first virtual model. *Id.* (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶ 147). Petitioner further states that tooth material removed around the finish line area to cure the inadequate definition, such that the claimed “second physical portion of said second physical part said finish line is adequately defined,” would be represented by the second 3D model. *Id.* (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶ 148). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 20.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 20.

Claim 21 depends from claim 19 and recites “said at least a part of said surface of interest comprises a preparation surface of a preparation of a tooth onto which it is desired to mount the prosthesis, wherein in said first physical portion of said first physical part said preparation surface is inadequate for mounting the prosthesis thereto, and wherein in said second physical portion of said second physical part said preparation surface is adequate for mounting the prosthesis thereto.” Petitioner cites Paley as disclosing an iterative crown prosthesis preparation in which a portion of a tooth onto which it is desired to mount the prosthesis is the claimed “at least part of said surface of interest [that] comprises a preparation surface of a preparation of a tooth onto which it is desired to mount the prosthesis,” but is inadequate for mounting the prostheses and is represented by the first virtual model. Pet. 48–49 (citing Ex. 1006 ¶¶ 62–65; Ex. 1010, Saber Decl. ¶ 151). Thus, continued preparation is required. *Id.* Petitioner notes that some tooth material is removed from the preparation surface of the preparation such that the claimed “second physical portion of said second physical part said preparation surface is adequate for mounting the prosthesis thereto” would be represented in the second 3D virtual model. *Id.* Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 21.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 21.

Claim 22 depends from claim 3 and recites “said first virtual model is distorted or deficient.” Petitioner cites Paley as disclosing that its first virtual model prior to correction is distorted or deficient, including with respect to “region 506 of omitted or missing data.” Pet. 49-50 (citing Ex. 1006 ¶¶ 38, 55–57, 59–60, 72–73, 77; Ex. 1010, Saber Decl. ¶¶ 153–154). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 22.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 22.

Claim 23 depends from claim 1 and recites the method further comprises “manufacturing a physical dental model of an intra-oral cavity based on said modified virtual model.” Petitioner cites Paley as disclosing manufacturing of “dental objects” from its scanned data. Pet. 50 (citing Ex. 1006 ¶¶ 26–27, 30, 72; Ex. 1010, Saber Decl. ¶¶ 155–157). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 23.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 23.

Claim 25 depends from claim 1 and recites the method further comprises “manufacturing a dental aligner based on said modified virtual model.” Petitioner cites Paley as disclosing “appliances” are “used to correct, **align**, or otherwise temporarily or permanently adjust **dentition, such as removable orthodontic appliances.**” Pet. 50 (quoting Ex. 1006, ¶ 26 (emphasis by Petitioner). Patent Owner does not respond explicitly to

Petitioner's arguments concerning the additional limitations recited in claim 25.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 25.

Claim 26 depends from claim 1 and recites the method further comprises "manufacturing orthodontic appliances based on said modified virtual model." Petitioner cites Paley as explaining that "appliances" are "used to correct, **align**, or otherwise temporarily or permanently adjust **dentition, such as removable orthodontic appliances.**" Pet. 51 (quoting Ex.1006, ¶ 26 (emphasis by Petitioner)). Petitioner notes that Paley explains that its virtual model can be used to manufacture "appliances". *Id.* (citing Ex. 1006 ¶ 30; Ex. 1010, Saber Decl. ¶¶ 161–163). Patent Owner does not respond explicitly to Petitioner's arguments concerning the additional limitations recited in claim 26.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 26.

Claim 27 depends from claim 27 and recites the method further comprises "manufacturing a dental prostheses based on said modified model." Petitioner notes that Paley explains that its virtual model can be used to manufacture "dental objects such as prosthetics." Pet. 51 (citing Ex. 1006 ¶ 30). Patent Owner does not respond explicitly to Petitioner's arguments concerning the additional limitations recited in claim 27.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 27.

Claim 28 is an independent claim drawn to a “system to generate a modified virtual model of a physical structure.” The limitations of system claim 28 correspond generally to the limitations of method claim 1. *See also*, Pet. 51–54. We find that Petitioner has demonstrated Paley and Kriveshko disclose the limitations of system claim 28 for the same reasons Paley and Kriveshko disclose the limitations of method claim 1. Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 28 and does not contend that claim 28 is patentably distinguishable from claim 1.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the limitations recited in claim 28.

Claim 29 depends from system claim 28 and recites “at least said identified portion of the first virtual model and the corresponding portion of the second virtual model are each representative of a physical portion of the physical structure, the first virtual model providing a deficient representation of the physical portion and the second virtual model providing an adequate representation of the physical portion.” Petitioner cites Paley’s disclosure of region 506 as a first virtual model with a deficient representation of a physical portion of the physical structure on the patient’s arch. *Id.* Petitioner cites Paley’s second virtual model as a rescan providing an adequate representation of the physical portion. *Id.* (citing Ex. 1010, Saber Decl. ¶¶ 180–182). Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 29.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the additional limitations recited in claim 29.

Claim 30 is drawn to a non-transitory computer readable medium having stored thereon a program that, when executed by a computer, causes the computer to carry out steps the generally correspond to those recited in method claim 1. The limitations of claim 30 correspond generally to the limitations of method claim 1 and system claim 28. *See also*, Pet. 56–58. We find that Petitioner has demonstrated Paley and Kriveshko disclose the limitations of system claim 30 for the same reasons Paley and Kriveshko disclose the limitations of method claim 1 and system claim 28. Patent Owner does not respond explicitly to Petitioner’s arguments concerning the additional limitations recited in claim 30 and does not contend that claim 30 is patentably distinguishable from claim 1.

Having reviewed the evidence and arguments of record, we are persuaded that Petitioner has demonstrated Paley and Kriveshko teach the limitations recited in claim 30.

Claim 31 depends from claim 30 and recites “at least said identified portion of the first virtual model and the corresponding portion of the second virtual model are each representative of a physical portion of the physical structure, the first virtual model providing a deficient representation of the physical portion and the second virtual model providing an adequate representation of the physical portion.” Noting that claim 31 includes language identical to claim 29, Petitioner contends, and we agree, that Paley and Kriveshko disclose all the limitations of claim 31.

Claim 32 depends from claim 30 and recites “the medium comprises one or more of optical discs, magnetic discs, magnetic tapes, or solid state memory storage.” Petitioner contends, and we agree, that the recitation of a magnetic disk as the computer readable medium does not patentably

distinguish claim 32. Patent Owner does not respond explicitly to Petitioner's contentions concerning claim 31.

14. Motivation to Combine the teachings of Paley and Kriveshko

As Petitioner points out, Paley incorporates Kriveshko by reference, for the purpose of explaining the specific technical way in which 3D scan data may be reacquired to modify Paley's virtual model. Pet. 60 (citing Ex. 1006 ¶¶ 60, 73, 77, 38. As Paley incorporates Kriveshko by reference, Kriveshko's teachings are already present in Paley.

Patent Owner contends that Petitioner's position requires modifying both Paley and Kriveshko with no motivation or rational for doing so. PO Resp. 44. Patent Owner argues that "[t]he solution to Paley and Kriveshko's problem is to acquire additional scan data and fill in the low density portions of the model." PO Resp. 47 (citing Ex. 2007, Saber Tr. 45:12–19 as explaining that Paley and Kriveshko teach that the solution to fuzziness and excessive texture is acquiring and adding more data). Thus, a fundamental premise of Patent Owner's argument that there is no motivation to combine the teachings of Paley and Kriveshko is that the combination of Paley and Kriveshko does not teach modifying the first virtual model by replacing at least part of the identified portion of the first virtual model with a corresponding portion of a second virtual model.

Patent Owner also contends that the mere fact Kriveshko characterizes data as "inaccurate" does not teach a person of ordinary skill how to invent a method of selecting and deleting such data. PO Resp. 44, 47–48. As an initial matter, we have not construed the "replacing" step of claim limitation 1.4 to require "deleting." See Section V.D. Nevertheless, even if the term "replace" is construed to require the one "delete" our analysis of claim

limitation 5.1 finds that the combination of Paley and Kriveshko discloses this feature. *See* Section VI.10(a).

We address the premise of Patent Owner’s arguments in our discussion of the individual limitations of claim 1. In our discussion of claim limitation 1.1 we note that Paley’s description of Figure 5 refers to “errors in a digital model, *such as* a region 506 of omitted or missing scan data.” *See* Section VI.A.5 (citing Ex. 1006 ¶ 59)(emphasis added). As discussed above for claim limitation 1.2, we are not persuaded by Patent Owner’s argument that Paley and Kriveshko are primarily concerned with voids in scan data. PO Resp. 50. *See* Section VI.A.6. Instead, we find that Paley and Kriveshko are concerned with correcting defective results and that a void is just an example of a defect. *See* Section VI.A.6 (citing Ex. 1006 ¶¶ 7, 55, 59 (“other errors such as excessive variability of surface data may be intrinsically identified by fuzziness or excessive random texture”)); Ex. 1007 ¶ 5. In our discussion of claim limitation 1.3 we found Petitioner explains how Kriveshko processes scanned data to develop a second model that is fit to the first model. Pet. 22 (citing Ex. 1007 ¶ 97 (disclosing “creating a supplemental model by fitting sequential frames to one another before a successful fit to the original three-dimensional model.”). *See* Section VI.7. As discussed above for claim element 1.4 we find that Paley explains its Figure 5 illustrates an “evaluation mode” in which a model containing errors is corrected using reacquisition techniques taught by (and incorporated by reference to) Kriveshko. *See* Section V.A.8 (citing Ex. 1006, Figure 5, ¶¶ 53, 58–60). We specifically note Kriveshko’s “landing mode” as an example. *Id.* In view of these findings, and the express incorporation by reference of Kriveshko into Paley, we are persuaded that a person of

ordinary skill would have had reason to combine the teachings of Paley and Kriveshko in the manner set forth in the challenged claims.

15. Conclusion as to claims 1–5, 8–13, 15–23, 25–32

In consideration of the above, we are persuaded that Petitioner has demonstrated that Paley and Kriveshko disclose all the limitations of claims 1–5, 8–13, 15–23, and 25–32 and that a person of ordinary skill would have had reason to combine the teachings of Paley and Kriveshko.

B. Claim 14 As Obvious Over Paley, Kriveshko and Babayoff

Claim 14 depends from claim 13 and recites “said first physical portion of said first physical part was obscured with a material including one or more of saliva, debris, or blood, and wherein said second physical portion of said second physical part corresponds to said first physical portion of said first physical part wherein said material has been removed from said surface of interest.” Claim 14 depends from claim 13, which depends from claim 12, which depends from claim 11, which depends from claim 5 discussed above.

Petitioner cites region 506 of Paley as disclosing the limitation in claim 11, that the first virtual model represents a first physical part of the physical structure and the first virtual model fails to comply with a predetermined requirement. Pet. 41–42. The subject matter of claim 12 recites that the predetermined requirement comprises providing high surface definition of a surface of interest in the first physical portion of the first physical part of the physical structure. As to this feature, Petitioner cites Paley’s disclosure that a point density may fall below a threshold. *Id.* at 42–43. The subject matter of claim 13 further limits claim 12, reciting that at least a part of the surface of interest is the first physical portion of the first physical part was obscured when the 3D virtual model was created and the

second physical portion of the second physical part corresponds to the first physical portion where the surface of interest was obscured. Petitioner argues that Paley states its scanning and analysis method is applicable to dental implants and abutments, and that a practitioner would remove the abutments and perform a second scan such that the portion of the dental implant is no longer obscured. *Id.* at 43–44.

The subject matter of claim 14 further limits claim 13, reciting that the obscured first physical portion is obscured with one or more of saliva, debris or blood and the second physical portion corresponds to the first physical part where the obscuring material has been removed from the surface of interest. Petitioner cites Babayoff as disclosing recognizing that such material impairs the ability of an imaging instrument and addresses the issue with an auxiliary device that ejects gas to the area to be imaged and provides suction to remove the material. Pet 62. Petitioner persuasively argues that, as the teachings of Paley and Kriveshko all involve intraoral scanners, a person of ordinary skill would have recognized the light reflectivity issues presented by such fluids and material and reasonably expected to achieve successful imaging by combining the teachings of the device in Babayoff with the methods taught in Paley and Kriveshko. *Id.* at 63–65.

Patent Owner argues that Petitioner fails to demonstrate Paley, Kriveshko, and Babayoff fail to disclose the limitations of claim 14 for the same reasons Paley and Kriveshko fail to disclose the limitations of claims 1 and 5. PO Resp. 58–59. As discussed above, we have determined that that a person of ordinary skill would have had reason to combine the teachings of Paley and Kriveshko and that their combined teachings disclose the features of claims 1 and 5. Patent Owner does not advance any arguments concerning Babayoff. For the reasons presented by Petitioner and discussed

above, we are persuaded that Petitioner has demonstrated a person of ordinary skill would have had reason to combine the teachings of Babayoff with those of Paley and Kriveshko to arrive at the limitations recited in claim 14.

C. Claim 24 As Obvious Over Paley, Kriveshko, and Chishti

Claim 24 depends from claim 1 and further comprises “designing an orthodontic treatment plan based on said modified model.” Petitioner cites Chishti as disclosing designing an orthodontic treatment plan based on a three-dimensional model, such as that disclosed in Paley or Paley and Kriveshko, and argues that a person of ordinary skill would have been motivated to combine the teachings of Chishti with Paley, given Paley’s discussion of using virtual models to produce orthodontic appliances. Pet. 65.

Patent Owner contends that Petitioner has failed to demonstrate that the combined teachings of Kriveshko and Paley disclose the limitations of claim 1 from which claim 24 depends. PO Resp. 59. As discussed above, we have determined that that a person of ordinary skill would have had reason to combine the teachings of Paley and Kriveshko and that their combined teachings disclose the limitations of claim 1. Patent Owner does not advance any arguments concerning Chishti. For the reasons presented by Petitioner and discussed above, we are persuaded that Petitioner has demonstrated a person of ordinary skill would have had reason to combine the teachings of Chishti with those of Paley and Kriveshko to arrive at the limitations recited in claim 24.

VII. CONCLUSION⁷

Having considered the evidence and arguments of record we conclude that Petitioner has demonstrated by a preponderance of the evidence (i) that claims 1–5, 8–13, 15–23, 25–32 are unpatentable under 35 U.S.C. § 103(a) as obvious over Paley and Kriveshko; (ii) that claim 14 is unpatentable under 35 U.S.C. § 103(a) as obvious over Paley, Kriveshko, and Babayoff, and (iii) that claim 24 is unpatentable under 35 U.S.C. § 103(a) as obvious over Paley, Kriveshko and Chishti.

In summary:

Claims	35 U.S.C. §	Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1–5, 8–13, 15–23, 25–32	103(a)	Paley, Kriveshko	1–5, 8–13, 15–23, 25–32	
14	103(a)	Paley, Kriveshko, Babayoff	14	
24	103(a)	Paley, Kriveshko, Chishti	24	
Overall Outcome	103(a)		1–5, 8–32	

⁷ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

VIII. ORDER

In consideration of the above, it is

ORDERED that claims 1–5 and 8–32 are unpatentable;

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.

IPR2019-00134
Patent 9,299,192 B2

FOR PETITIONER:

Todd Walters
Roger Lee
Andrew Cheslock
Bryan Cannon
Todd.walters@bipc.com
Roger.lee@bipc.com
Andrew.cheslock@bipc.com
Bryan.cannon@bipc.com

FOR PATENT OWNER:

Roger Sterne
Rsterne-ptab@sternekessler.com

Jason Eisenberg
Jasone-ptab@sternekessler.com

Salvador Bezos
Sbezos-ptab@sternekessler.com

Kristina Caggiano Kelly
Kckelly-ptab@sternekessler.com

Keyur Parikh
Kparikh-ptab@sternekessler.com