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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3SHAPE A/S and 3SHAPE INC.
Petitioners

v.

ALIGN TECHNOLOGY, INC.
Patent Owner

Case No. IPR2020-00222
Patent 7,156,661

PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 7,156,661 B2 UNDER 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq*.

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I. INTRODUCTION

3Shape A/S and 3Shape Inc. ("3Shape" or "Petitioners") respectfully request *inter partes* review for claims 1-4, 6, 19-22, and 26 of U.S. Patent No. 7,156,661, issued on January 2, 2007 to Woncheol Choi et al. ("the '661 Patent") (Ex.1001) in accordance with 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq*.

II. MANDATORY NOTICES PURSUANT TO 37 C.F.R. § 42.8(A)(1)

A. Real Party-In-Interest

Pursuant to 37 C.F.R. § 42.8(b)(1), Petitioners certify that 3Shape A/S, 3Shape Inc., 3Shape Holding A/S, 3Shape Trios A/S, and 3Shape Poland sp. z.o.o. are real parties-in-interest. Out of an abundance of caution, 3Shape Medical A/S, 3Shape Germany GmbH, 3Shape France SAS, 3Shape Italy SRL, 3Shape S.A.S., 3Shape (Shanghai) Co., Ltd., 3Shape Do Brasil Soluções Tecnologicas Para Saude Ltda, 3Shape Australia Pty Ltd., 3Shape Trios Sociedad Limitade, 3Shape Japan GK, 3Shape Ukraine Ltd., 3Shape (UK branch), SC Investment Company, LLC, Drop Dental LLC, Shenzhen Full Contour Design Company Ltd., Bosques Humedos Del sur Sociedad De Responsabilidad Limitada, Full Contour SRL, Full Contour LLC, 3Shape Medical Equipment Manufacture Shanghai Ltd., 3Shape Korea Ltd., 3Shape Manufacturing US LLC, Clausen Engineering APS, Tais Clausen, Deichmann Media APS, Nikolaj Hoffmann Deichmann, and the individuals listed in Appendix B are also identified as real parties-in-interest, for purposes of compliance with 35 U.S.C. § 312(a)(2).

B. Identification of Related Matters Under 37 C.F.R. § 42.8(b)(2)

The following is a list of any judicial or administrative matters that would affect, or be affected by, a decision in this proceeding:

Align Technology, Inc. v. 3Shape A/S, Civil Action No. 1:18-cv-01950 (D. Del.) (Complaint filed December 11, 2018) ("Delaware litigation");

In the Matter of Certain Dental and Orthodontic Scanners and Software, Inv. No. 337-TA-1144 (U.S. International Trade Commission) (Complaint filed December 10, 2018) ("ITC Investigation");

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 7,156,661, IPR2020-00223 (to be filed);

U.S. Patent Application No. 10/640,439, filed on August 12, 2003, which issued as U.S. Patent No. 7,156,661 on January 2, 2006; and

U.S. Patent Application No. 10/225,889, filed on August 22, 2002, which issued as U.S. Patent No. 7,077,647 on July 18, 2006.

C. Lead and Backup Counsel

Pursuant to 37 C.F.R. §§ 42.8(b)(3) and 42.10(a), Petitioners hereby identify their lead and backup counsel as follows:

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Powers of Attorney are being filed concurrently herewith in accordance with 37 C.F.R. § 42.10(b).

D. Service Information Under 37 C.F.R. § 42.8(b)(4)

Petitioners consent to e-mail service at the addresses listed above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge Deposit Account No. 02-4800 for the fees required by 37 C.F.R. § 42.15(a).

IV. REQUIREMENTS UNDER 37 C.F.R. § 42.104

A. Grounds for Standing

Pursuant to 37 C.F.R. § 42.104(a), Petitioners hereby certify that the ’661 Patent is available for *inter partes* review in accordance with 37 C.F.R. § 42.102(a)(2), and that Petitioners are not barred or estopped from requesting *inter partes* review challenging the claims of the ’661 Patent on the grounds identified in this Petition.

This Petition is filed within one year from the date on which Petitioner 3Shape A/S was served a Complaint by Patent Owner in the related litigation, *Align Technology, Inc. v. 3Shape A/S*, Civil Action No. 1:18-cv-01950 (D. Del.), which asserted infringement of the ’661 Patent.

Neither Petitioners nor any privies of Petitioners have received a final written decision under 35 U.S.C. § 318(a) with respect to any claim of the ’661 Patent on any ground that was raised or could have been raised by Petitioners or privies of Petitioners in any *inter partes* review, post grant review, or covered business method patent review.

B. Identification of Challenges and Precise Relief Requested

Petitioners challenge claims 1-4, 6, 19-22, and 26 of the ’661 Patent (“the challenged claims”), and request that these claims be found unpatentable over the prior art in view of the following grounds.

Ground	References	Basis	Claims Challenged
1	Commer (Ex.1011)	35 U.S.C. § 102	1-4, 19-22
3	Commer (Ex.1011) in view of Ashmore (Ex.1009)	35 U.S.C. § 103	1-4, 6, 19-22, 26

In addition to the above prior art, Petitioners rely upon the evidence listed in the Exhibit List, including the Declaration and *Curriculum Vitae* of Dr. Eli Saber. (Exs.1005, 1006).

C. Prior Art Qualification of Asserted References

The ’661 Patent issued from Application No. 10/640,439 (“the ’439 application”) filed on August 12, 2003, which is a continuation-in-part of Application No. 10/225,889 (“the ’889 application”, Exs.1003-1004) filed on August 22, 2002. Each of the asserted references identified below constitutes prior art under § 102(b) or § 102(a) with respect to the earliest possible effective filing date of the ’661 Patent.[1]

Commer published in April of 2001, and thus is prior art at least under 35 U.S.C. § 102(b). Ashmore published in January of 2002, and thus is prior art at least under 35 U.S.C. § 102(a). Petitioners submit the Declaration and Curriculum Vitae

[1] Petitioners do not concede that any challenged claim is entitled to an effective filing date of August 22, 2002.

of Dr. Sylvia D. Hall-Ellis (Exs.1007, 1008), an expert in the field of library cataloging and classification. The testimony of Dr. Hall-Ellis demonstrates that Commer was published and accessible to the public on April 6, 2001. Ex.1007. *See id.*, ¶¶53-59, 73. The testimony of Dr. Hall-Ellis demonstrates that Ashmore was published and accessible to the public on January 30, 2002. Ex.1007. *See id.*, ¶¶40-46, 73. Thus, Commer and Ashmore are prior art under § 102(a) and/or § 102(b).

V. BACKGROUND

A. The ’661 Patent and Technical Background

1. Matching computer models to measure teeth movement was well known

The ’661 Patent describes techniques for treatment analysis by teeth matching utilizing computer models. Ex.1001, title, 2:15-19, 9:14-23, 9:32-53, Fig. 10A. The ’661 Patent discloses "taking two digital models, one before treatment and one after treatment, superimposing them in the virtual space, and calculating the movement of each tooth." *Id.*, 2:15-18. The’661 Patent discloses the use of digital dental models allows for precise measurements and accurate teeth matching. *Id.*, 2:9-11. However, matching digital dental models to accurately assess changes to teeth over time was well known at the time of the purported invention. Exs.1011, 1009. Ex.1005, ¶27.

2. Use of reference points on a stable region to match computer dental models was well known

The ’661 Patent discloses using stable anatomical regions such as the palatal rugae to obtain good matching of the initial and subsequent models. Ex.1001, 2:41-44, 11:2-5. However, it was well known to use points on the palate as a reference to match models. Ex.1011. Selecting points from palatal rugae, which is a part of the palate, for matching computer dental models was also well known. Ex.1009, 21 (using “palatal rugae points as the registration landmarks”); Ex.1016, title (“Stability of the palatal rugae as landmarks for analysis of dental casts”), Fig. 1, abstract. Ex.1005, ¶28.

3. Registration and superposition, which result in matching according to the ’661 Patent, were well known

The ’661 Patent describes that “registration” and “superimposing” of the initial and subsequent models achieves matching of the models:

> The ***registration*** process is accomplished by determining a transformation T that minimizes the discrepancy between D1 and D2…. An iterative optimization method is employed to refine the solution until ***a best fit match*** is found…
>
> The search algorithm finds the relative position of the teeth by minimizing the distance between two ***superimposed*** teeth. ***The matching process*** is completed throughout the entire teeth of a jaw. After ***matching*** the teeth…

Ex.1001, 5:36-42, 8:52-59 (emphases added). *See also id.*, 10:62-11:5, 10:62-64 ("The system thus provides a 3-dimensional superimposition tool that measures dental changes based on an algorithm of best fit"). However, registering and superimposing models (which the '661 Patent discloses results in matching), and minimizing distance between superimposed models, were well known. Exs.1009, 1011, 1017. Ex.1005, ¶29.

4. The rugae embodiment of the '661 Patent

Fig. 10A of the '661 Patent describes a process encompassed by the independent claims that uses rugae for matching:

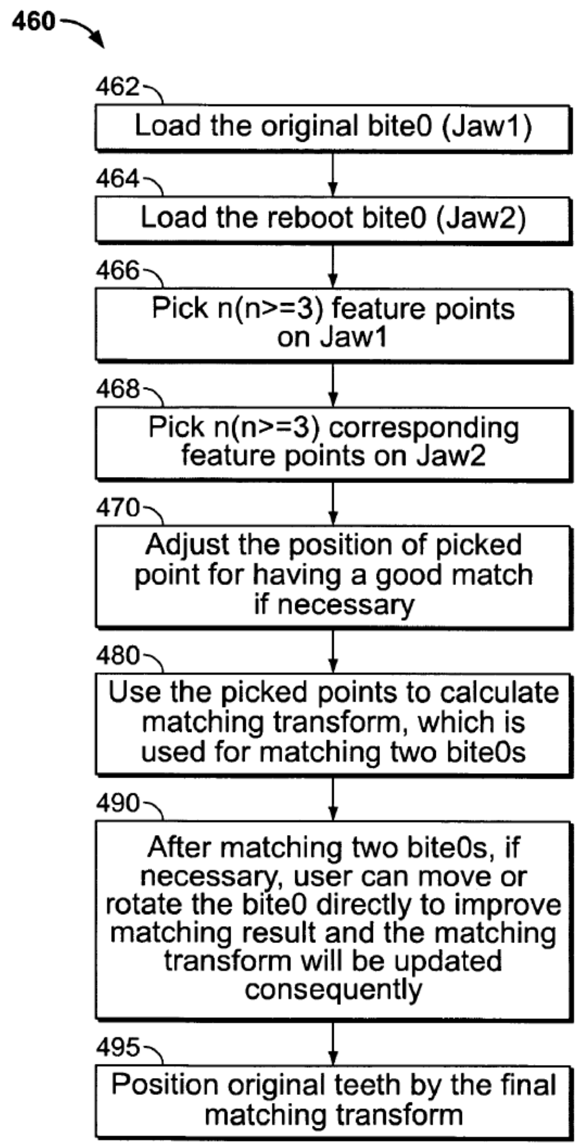

FIG. 10A

Fig. 10A of the '661 Patent

Two models (Jaw1, Jaw2) are loaded at 462 and 464. Ex.1001, 9:32-34. At 466 and 468, points on a region (rugae) of Jaw1 and corresponding points on a corresponding region (rugae) of Jaw2 are identified. *Id.*, 9:14-20 ("rugae region"), 9:35-37. At 480, the picked points and corresponding points are used to calculate a "matching transform" for the rugae region. Ex.1001, 9:14-20 ("rugae region"), 9:46-48. Item

480 also includes "matching" Jaw1 and Jaw2 using the matching transform for the rugae region. *Id.*, 9:14-20 ("rugae region"), 9:46-51. This (second) "matching" is distinct from the (first) matching of calculating the matching transform (in 480), and the (third) matching in 490. *Id.*, 9:46-61 (490 occurs "[a]fter matching two scanned jaw models."). Ex.1005, ¶30.

B. Prosecution History

During prosecution, the Examiner rejected the original claims based on U.S. Patent No. 6,250,918 (Sachdeva) alone and in combination U.S. Patent No. 6,068,482 (Snow). Ex.1002, 73-75. Patent Owner obtained allowance by arguing that Sachdeva does not disclose that the reference point is on a region comprising a portion of the jaw other than the teeth (*e.g.*, rugae on a palate of the jaw). *Id.* 63-65 (Patent Owner's argument), 45 (examiner's reasons for allowance states Sachdeva "does not teach the [point] exterior [to the tooth] is a region of the model."). However, it was well known to use the palate (and reference points on palatal rugae) to compare initial and subsequent 3D tooth models. Ex.1011; Ex.1009, 21, 22; Ex.1016, title, abstract.

The Examiner also noted that "Sachdeva does not teach matching the jaw models as a whole in addition to calculating the differences between individual teeth." Ex.1002, 45. However, it was well known to apply a transform to models of jaw to match them as a whole. Ex.1011, 632.

C. Person of Ordinary Skill in the Art

A person of ordinary skill in the art ("POSITA") is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. With respect to the '661 Patent, one of ordinary skill in this art would have at least: (1) a bachelor's degree in electrical and/or computer engineering, or computer science (or equivalent course work) with two to three years of work experience in computer modelling of physical structures or (2) a master's degree in electrical and/or computer engineering, or computer science (or equivalent course work) with a focus in computer modelling of physical structures.[2] Ex.1005, ¶25.

D. Overview of the Prior Art

Commer

Commer discloses a computer-based intraoral laser scanning system for acquiring intraoral data for orthodontic applications. Ex.1011, Abstract ("translational and rotational parameters gained from the superimposition of scanned point clouds … describ[e] tooth movement"); 632. Commer's scanning system is shown below:

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[2] Patent Owner offered a description of a POSITA. Ex.1014, 8-10. Petitioners and Patent Owner agree a POSITA need not have any dental experience. *Id.* The challenged claims would have been obvious under either description.

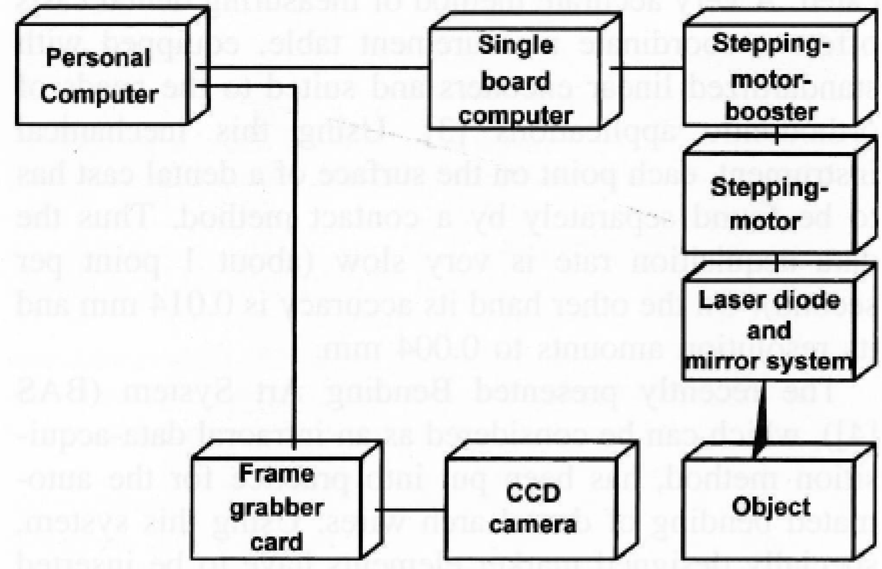

Fig. 1. Schematic diagramme of the developed laser scanning system.

Fig. 1 of Commer

Commer's scanning system is for scanning a patient's mouth. *Id.*, Fig. 2 ("an intraoral scanner which fits into the patient's mouth"); 626, 634 ("data acquisition method for retrieving tooth positions and orientations … directly in the mouth."). Commer discloses its scanning system can be used to scan casts of a patient's jaw, and does so in examples. *Id.*, Abstract ("scanning plaster casts"). Commer scans physical dental casts to assess the accuracy of its system. *Id.*, Abstract; 632. Scanning the physical casts provide data sets to generate point clouds. *Id.*, 626, 628. A model (*e.g.*, "surface") of the physical cast is generated from the point cloud using triangulation algorithms. *Id.*, 629 ("For better visibility a surface was generated from the point cloud using triangulation algorithms."); *see also* Ex.1031. Ex.1005, ¶33.

Commer discloses that its scanning system is for measuring tooth movement resulting from orthodontic treatment. Ex.1011, 626 ("determination of three-dimensional tooth movements", "achieve three-dimensional digitization of the jaw"), 632 ("Reconstruction of orthodontic tooth movement", "jaws or plaster casts"). Commer discloses scanning a first physical cast (representing an initial treatment situation of a patient's jaw) and a second physical cast (representing a subsequent treatment situation of the patient's jaw) to measure tooth movement. *Id.* For testing purposes, the second physical cast was created by physically repositioning a molar tooth in the first physical cast. *Id.* The scanning creates first and second point clouds, respectively. *Id.* Each point cloud is used to generate a model (*e.g.*, "surface") of the patient's jaw. *Id.*, 629 ("a surface was generated from the point cloud using triangulation algorithms"), 632 ("data points defining the surface of an object … surfaces have been generated from the point clouds"). Commer refers to these virtual models of the initial and subsequent treatment situations as "cast 1" and cast 2", respectively. *Id.*, 632. Ex.1005, ¶34.

Commer discloses a 3-step process for determining tooth movement. Ex.1011, 632 (steps 1-3). Commer utilizes a "surface-surface matching" technique at different points in its 3-step process:

> The translational (X, Y, Z) and the rotational (ϕ, Θ, Ψ) parameters of the movement can be determined by a numerical superimposition of two point clouds. This is equivalent to the minimization function f(X, Y, Z,

> ϕ, Θ, Ψ) that defines the distance between the point clouds by the sum of the distances of each individual point in cloud one and two. The process is called surface-surface matching [16] and was implemented using an iterative procedure.

Ex.1011, 632. Prior to performing the 3-step process, data sets for casts 1 and 2 are each segmented into a palate point cloud and teeth point clouds. *Id.* ("data sets have been segmented into separate clouds"). Surfaces for each segmented point cloud are generated. Ex.1011, 632 ("[s]urfaces have been generated from the point clouds"). The surfaces for casts 1 and 2 are then assembled into their respective coordinate systems as shown in Fig. 8a. *Id.*, 632 ("Fig. 8a shows both plaster casts in different coordinate systems…."), 634 ("Segmented point clouds with reconstructed surfaces as measured with our intraoral scanner during different stages of tooth movement. (a) Separated casts….").

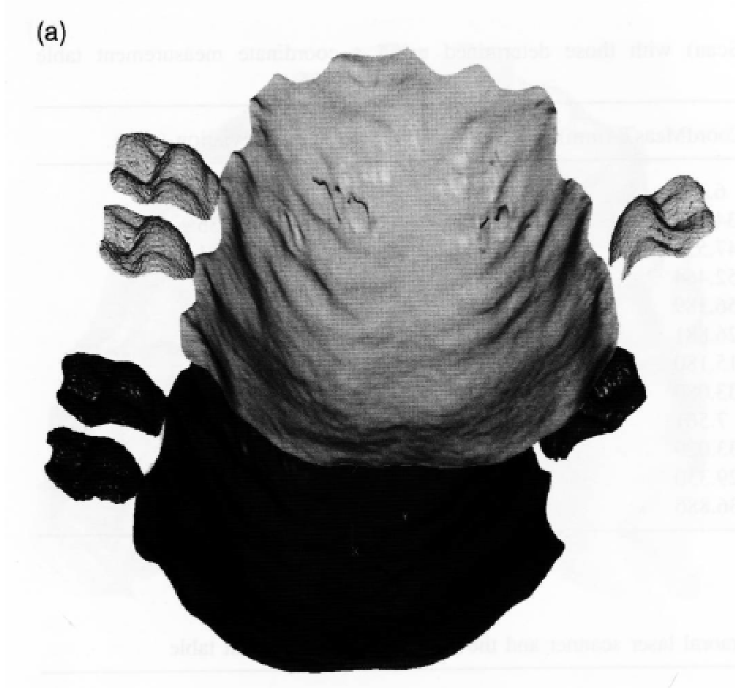

Fig. 8a of Commer

As shown in Fig. 8a, cast 1 (which includes palate and tooth surfaces) is a computer model. *Id.*, 632 (describing cast 1 as a "surface"). Similarly, cast 2 (which includes palate and tooth surfaces) is a computer model. *Id.* Ex.1005, ¶35.

In the first step of Commer's process, the palate surface of cast 2 (representing the subsequent treatment situation) is matched to the palate surface of cast 1 (representing the initial treatment situation). Ex.1011, 632. This matching utilizes the surface-surface matching technique described above and produces the appropriate translational and rotational parameters. *Id.* Ex.1005, ¶36.

In the second step, the translational and rotational parameters produced in the first step are applied to the teeth surfaces of cast 2 to place them in the same reference frame/coordinate system as cast 1. Ex.1011, 632. Fig. 8b depicts the result of performing the second step:

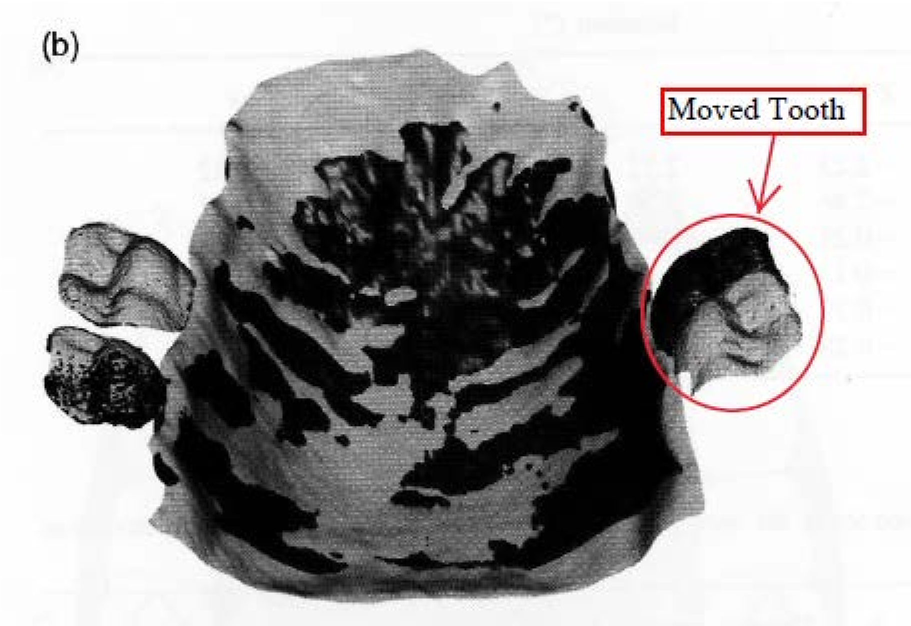

Fig. 8b of Commer (Annotated)

Id. As shown by the red circle, the right molar is depicted as being moved. *Id.*, 632. Ex.1005, ¶37.

In the third step, the distance between points on corresponding molar reference teeth in the two models are minimized to produce movement parameters (X,Y,Z,ϕ,Θ,Ψ). Ex.1011, 632. To calculate positional differences (X,Y,Z,ϕ,Θ,Ψ) of the tooth in its moved position (in cast 2) in comparison with the tooth in its initial position (in cast 1), the minimization function is also performed on the moved tooth. *Id.* The calculations of the movement parameters for the moved tooth were compared to a coordinate measurement table ("CoordMeasT") to determine the accuracy of Commer's scanning system. Table 2 provides the results:

Table 2
Comparison of the results of the reconstructed tooth movement for the intraoral laser scanner and the coordinate measurement table

		Translation (mm)			Rotation (°)		
		X	*Y*	*Z*	*φ*	*θ*	*ψ*
Molar	CoordMeasT	−5.83	−0.99	−2.23	2.52	1.02	0.22
	IOLaScan	−6.30	−0.96	−2.46	2.20	0.76	0.27
Ref. tooth 1	CoordMeasT	−0.16	0.07	−0.21	0.67	−0.70	0.66
	IOLaScan	0.25	0.08	−0.13	0.23	−0.76	0.01
Ref. tooth 2	CoordMeasT	−0.11	0.11	−0.39	0.03	−0.01	0.01
	IOLaScan	0.43	0.04	−0.28	0.32	−1.60	0.16

Table 2 of Commer

Ex.1005, ¶38.

Commer concludes that its scanning system provides sufficient accuracy for measuring tooth movement. Ex.1011, 634, abstract ("The achieved accuracy proved to be sufficient…."). Commer discloses that scanning system performance is "very promising, except for point to point measurements." *Id.*, 634. Commer discloses that its technique provides sufficient overall point-to-point accuracy even if outlier point(s) (having a deviation up to 0.6 mm) are present among the point to point measurements as a "consequence of the limited resolution and accuracy of the laser scanning principle." *Id.*, 629-632. Commer discloses that accuracy of the outlier point(s) (and the process as a whole) can be improved by using a CCD chip with increased resolution, increasing laser intensity, or decreasing the width of the laser line. *Id.*, 634, abstract (suggesting use of "more precise device components"). Ex.1005, ¶39.

Ashmore

Ashmore discloses a method "for superimposing 3-dimensional data obtained from selected landmarks" on dental casts. Ex.1009, abstract. Ashmore discloses using palatal rugae as landmarks for matching the initial model of a patient's teeth obtained before headgear treatment with subsequent models obtained after headgear treatment to assess tooth movement:

> Spatial data from each subject's initial model were oriented similarly in an anatomically derived coordinate system, and a best-fit superimposition of palatal rugae landmarks from subsequent models allowed the measurement of molar movement.

Id., abstract. Ex.1005, ¶40.

VI. HOW THE CHALLENGED CLAIMS ARE TO BE CONSTRUED

Claim terms are interpreted according to *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. Some of the claim terms of the '661 Patent are disputed in the ITC investigation. Exs.1014, 1020-1023. Any claim terms not addressed should be interpreted consistent with the *Phillips* standard. The challenged claims would have been obvious over the asserted prior art under all of the below constructions.

A. "reference point"

In the ITC investigation, Petitioners construed "reference point" as "a point on a stable anatomical structure." Ex.1014, Appendix A, 7-11. Petitioners adopt this construction for purposes of this proceeding. This construction is consistent with the '661 Specification, which discloses that "[s]table structures such as the palatal rugae can be used as stable external reference points." Ex.1001, 11:2-4.

In the ITC investigation, the ALJ construed the term "reference point" as "a point used to determine the position of a computer model, or part thereof, relative to another computer model, or part thereof". Ex.1014, Appendix A, 7-11. Patent Owner asserted that no construction is necessary and alternatively the proper construction of "reference point" is the plain and ordinary meaning which is "points used to determine the position of a computer model relative to another computer model." *Id.*

B. "region(s)"

In the ITC investigation, Petitioners construed "region(s)" as "portion(s)." Ex.1014, Appendix A, 11-14. Petitioners adopt this construction for purposes of this proceeding. This construction is consistent with the '661 Specification, which indicates that the region is something less than the entire computer model. *See, e.g.*, Ex.1001, 9:17-20.

In the ITC investigation, the ALJ construed the term "region(s)" as "area". Ex.1014, Appendix A, 11-14. Patent Owner asserted that no construction is necessary and alternatively the proper construction of "region(s)" is the plain and ordinary meaning which is "area." *Id.*

C. "matching/match … using the identified reference points"

In the ITC investigation, Petitioners construed "matching/match … using the identified reference points" as "positioning/position … using the identified points on the stable anatomical structures." Ex.1014, Appendix A, 14-19. Petitioners adopt this construction for purposes of this proceeding. "Positioning" satisfies "matching" according to the '661 Specification. *See, e.g.*, Ex.1001, 9:17-20 ("These points are then matched such that the models are positioned so they closely align in the regions around the points (i.e. the rugae region), by applying a transform T_{ref} to one of the models."); 6:32-34 ("a second matching operation is performed to determine the position of the new jaw relative to the original coordinate system").

In the ITC investigation, the ALJ construed the term "matching/match … using the identified reference points" as "using the identified reference points to determine the position of a region of the first computer model relative to the corresponding region of the second computer model". Ex.1014, Appendix A, 14-19. Patent Owner asserted that no construction is necessary and alternatively the proper construction of "reference point" is the plain and ordinary meaning which is "matching the region on the first and second computer models using the identified points to determine the position of a computer model relative to another computer model." *Id.*

D. "comprising a portion of the jaw/model other than the teeth"

In the ITC investigation, the ALJ construed the term "comprising a portion of the jaw/model other than the teeth" as "including at least a non-tooth portion of the jaw". Ex.1014, Appendix A, 19. Petitioners adopt this construction for purposes of this proceeding. Petitioners and Patent Owner agreed to this construction in the ITC Investigation. *Id.*

VII. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING

The challenged claims are unpatentable over the prior art.

A. Claims 1-4 and 19-22 are Anticipated by Commer [Ground 1]

The following sections provide reference to where the elements of claims 1-4 and 19-22 are found in the prior art (*see also* Section V.D.), in light of the constructions set forth in Section VI.

1. Claim 1 (Element [1.P]): A method for matching computer models of a jaw, the method comprising:

Commer discloses the preamble of claim 1.[3] Ex.1005, ¶51.

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[3] Petitioners do not concede that any preamble of the challenged claims is limiting.

"A method for matching"

Commer discloses a method for matching (*e.g.*, "matching", "superimposing", "determin[ing] three-dimensional tooth movement") computer models (*e.g.*, "cast 1", "cast 2", "surface") of a jaw (*e.g.*, "three-dimensional digitization of the jaw", "digitization of the shape of a jaw into a computer"). Ex.1011, 626, 632, abstract. Ex.1005, ¶52.

Commer discloses matching computer models. Ex.1011, 632 (*e.g.*, "surface-surface matching", "The surface of the palate … was matched", "Final matching procedures"). Commer discloses "superimposition" of models (*e.g.*, "cast 1", "cast 2") to determine teeth movement. *Id.*, abstract ("translational and rotational parameters gained from the superimposition of scanned point clouds and describing tooth movement"), 632 ("The translational (X, Y, Z) and the rotational (ϕ, Θ, Ψ) parameters of the movement can be determined by a numerical superimposition of two point clouds."), Figs. 8(a)-8(c) (depicting the superimposition process). Commer's superimposition satisfies the claimed "matching." This is because superimposition and registration of initial and subsequent models achieves matching according to the '661 Patent (*see* Section V.A.3.). Ex.1001, 5:36-42, 8:52-59, 10:62-11:5, 10:62-64. Ex.1005, ¶53.

"computer models of a jaw"

Commer scans a physical dental cast (or actual oral cavity of a patient) which provides a point cloud. Ex.1011, 626, 628, 632. A computer model of the cast (*e.g.*, "surface", "cast 1", "cast 2") is generated from the point cloud using triangulation algorithms. *Id.*, 629 (" [A] surface was generated from the point cloud using triangulation algorithms."). The model is a "computer" model because it is a "three-dimensional digitization of the jaw" and is accessed and manipulated by Commer's "computer-based" technique. *Id.*, 626 ("achieve three-dimensional digitization of the jaw"), title. Commer's scanning system utilizes a "computer" as shown in FIG. 1:

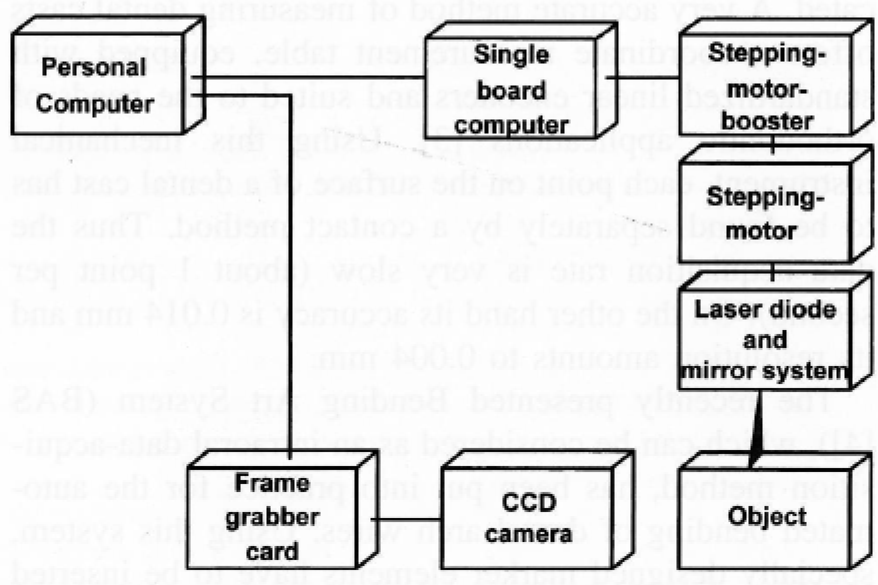

Fig. 1. Schematic diagramme of the developed laser scanning system.

Fig. 1 of Commer

Commer's computer models (and point clouds of the models) represent a jaw of the patient. *Id.*, 626 ("achieve three-dimensional digitization of the jaw", "Direct three-dimensional digitization of the shape of a jaw into a computer"), 632 ("jaws or plaster casts"), Figs. 8(a)-8(c) (depicting jaw models). Ex.1005, ¶54.

2. Element [1.1] loading a first computer model of a jaw having teeth in initial positions;

Commer discloses Element [1.1]. Ex.1005, ¶55.

"loading"

Commer discloses "loading" a first computer model because Commer discloses that the computer model is stored in a computer and accessed and manipulated via software:

> Direct three-dimensional digitization of the shape of a jaw into a computer allows the immediate access on the data and the instant execution of numerical calculations, for example the surface reconstruction or the determination of three-dimensional tooth movements.…

Ex.1011, 626. *See also id.*, 626 (system includes "personal computer running the control software"), Figs. 1 and 2, 628 ("Further tasks of the control software, following data acquisition, include calculations of real three-dimensional space coordinates out of screen coordinates and rendering of the scanned object surfaces represented by the point clouds"), 634 ("a computer aided orthodontic treatment planning system"). A POSITA would have understood that Commer's models are "loaded" during Commer's scan and surface generation and "data acquisition" processes, because it is well understood that loading allows for the data to be accessed by software (*e.g.*, to allow the data to be displayed and/or manipulated). Ex.1027, 39:7-43:27 (the program downloads the 3D data file to utilize the file); Ex.1012, ¶[0120] (data is "loaded into the workstation, and accessed from the treatment planning software"). Ex.1005, ¶56.

"first computer model of a jaw having teeth in initial positions"

Commer discloses a "computer" model as explained for Element [1.P]. Ex.1005, ¶57.

Commer discloses a first computer model of a jaw (*e.g.*, digitized "first cast", "cast 1", "surface of the reference cast 1") having teeth in initial positions (*e.g.*, "initial treatment situation").[4] Ex.1011, 632. Commer discloses a digitized surface of cast 1 representing an "initial treatment situation" of a patient's jaw:

> For the reconstruction of an orthodontic tooth movement, jaws or plaster casts of intraoral situations before and after a certain treatment step have to be measured: ***the first point cloud represents the initial situation whereas the second one represents a final situation, where teeth have been moved and/or rotated***.…
>
> The first cast [*i.e.*, reference cast 1] serves as a reference, defining the ***initial treatment situation***, in the second one [*i.e.*, cast 2] molar tooth

[4] The terms "cast 1" and "cast 2" refer to the computer models of the physical casts.

> was taken out and repositioned at a given distance to the original position. Both casts were scanned….
>
> Surfaces have been generated from the point clouds and the data sets have been segmented into separate clouds….

Ex.1011, 632 (emphases added). Fig. 8(a) depicts the first and second computer models (casts 1 and 2):

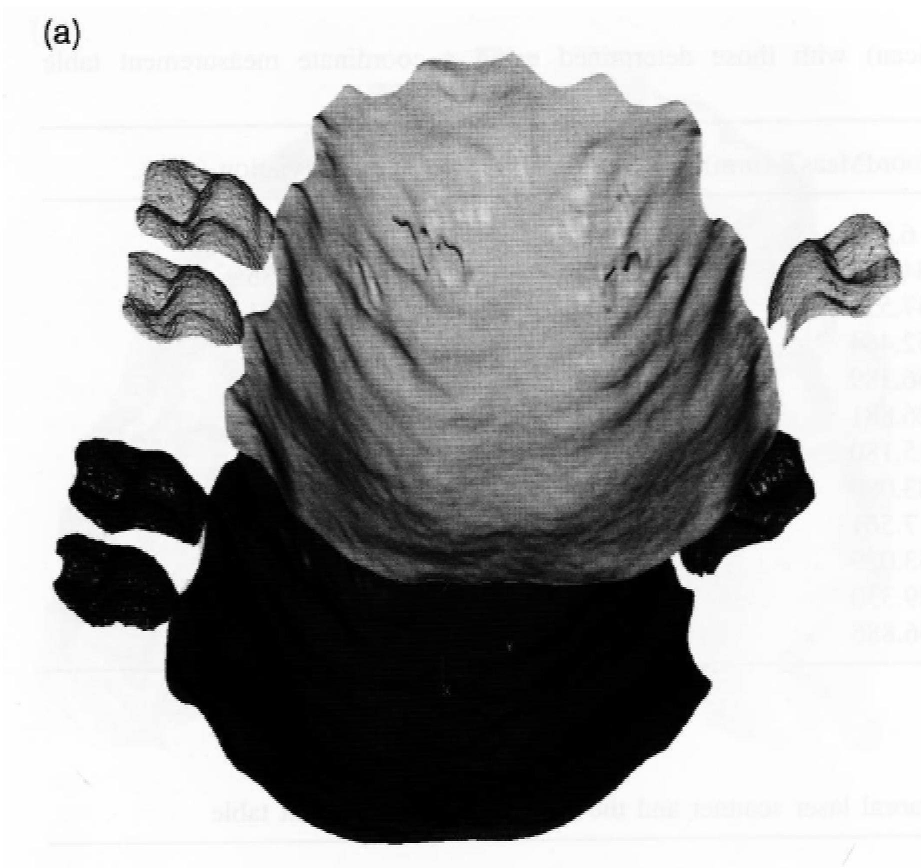

Fig. 8a of Commer

Id., 634, Fig. 8a. While casts 1 and 2 are in different coordinate systems, the segmented palate and teeth surfaces of cast 1 are in the same coordinate system. *Id.*, 632 ("Fig. 8a shows both plaster casts in different coordinate systems."). The segmented surfaces of cast 1 together constitute the first computer model. Ex.1001, 5:15-65 (a "segmented" model still constitutes a model). The teeth of the first computer model (cast 1) are in "initial positions" ("initial situation" of the teeth) in comparison with the teeth of the second computer model (cast 2) in which a tooth has been moved ("final situation" of the teeth), discussed below for Element [1.2]. Ex.1011, 632. Ex.1005, ¶58.

3. Element [1.2]: loading a second computer model of the jaw, wherein positions of at least some of the teeth in the second computer model are different than the initial positions;

Commer discloses Element [1.2]. Ex.1005, ¶59.

Commer's second computer model (*e.g.*, "cast 2") is loaded in similar fashion to the first computer model (*e.g.*, "cast 1"). Ex.1011, 626, 628; Ex.1027, 39:7-43:27; Ex.1012, ¶[0120]. *See* Element [1.1]. Commer discloses a "computer" model. *See* Element [1.P]. Ex.1005, ¶60.

As noted above concerning Element [1.1], Commer teaches a second computer model of the jaw (*e.g.*, "cast 2") where at least some positions of the teeth in the second computer model are different than the initial positions. Ex.1011, 632. This is because Commer discloses the second computer model (*e.g.*, "cast 2") represents "a final situation, where teeth have been moved and/or rotated." *Id.* As shown in Fig. 8a above, the segmented palate and teeth surfaces of cast 2 are in a single, common coordinate system. The segmented surfaces of cast 2 together constitute the second computer model. Ex.1001, 5:15-65 (a "segmented" model still constitutes a model). Ex.1005, ¶61.

In Commer's testing, cast 2 was created by repositioning one molar tooth. Ex.1011, 632 ("in the second [cast] molar tooth was taken out and repositioned at a given distance to the original position"). Commer discloses that cast 2 may include movement of multiple teeth and not just a single molar tooth. *Id.*, 632 ("…the second one represents a final situation, where teeth have been moved and/or rotated."). This would also be the case when Commer's technique is applied to an actual patient's oral cavity. *Id.* Ex.1005, ¶62.

4. Element [1.3]: identifying at least one reference point on a region of the first computer model, the region comprising a portion of the jaw other than the teeth;

Commer discloses Element [1.3]. Ex.1005, ¶63.

"identifying at least one reference point"

Commer discloses identifying at least one reference point (*e.g.*, points of the point cloud of the palate surface of cast 1). Ex.1011, 632. Ex.1005, ¶64.

Commer's first computer model ("cast 1") includes a segmented palate surface that includes a palate point cloud. Ex.1011, 632 ("Surfaces have been generated from the point clouds and the data sets have been segmented into separate clouds of the palate..."), 629 ("surface was generated from the point cloud using triangulation algorithms"). The palate point cloud includes points which are on a region (*e.g.*, segmented palate surface). *Id.* The points of the palate point cloud are identified during Commer's surface-surface matching technique (in step 1 of Commer's 3-step process) because Commer discloses that "each individual point" in the clouds are used to define the distance between the point clouds. *Id.* ("defines the distance between the point clouds by the sum of the distances of each individual point in cloud one and two."). The points in the palate point cloud are identified because their positions are used in Commer's surface-surface matching technique. *Id.* Ex.1005, ¶65.

Thus, Commer's identified points (*e.g.*, points of the palate point cloud of the palate surface of cast 1) are used to determine the position of a computer model or part thereof relative to another model or part thereof, thus satisfying the ALJ's and Patent Owner's constructions of "reference point". This is because Commer discloses using the points to bring "palates and teeth of both casts … in a common reference frame." Ex.1011, 632. Ex.1005, ¶66.

As evidenced by Ashmore, the palate disclosed in Commer includes palatal rugae which is a stable anatomical region of the jaw. Ex.1009, 19 ("Palatal rugae retain their shape and pattern throughout a person's lifetime", " parts … of palatal rugae may be sufficiently stable to serve as an anatomic reference"); *see also* Ex.1016, 43 ("palatal rugae may possess ... reasonable stability"), 48. Thus, Commer's palate point cloud includes points on a stable anatomical structure, satisfying Petitioners' construction of "reference point". *Id.* Ashmore cites Almeida (Ex.1016) which discloses using landmarks on the palatal rugae that are on the palate:

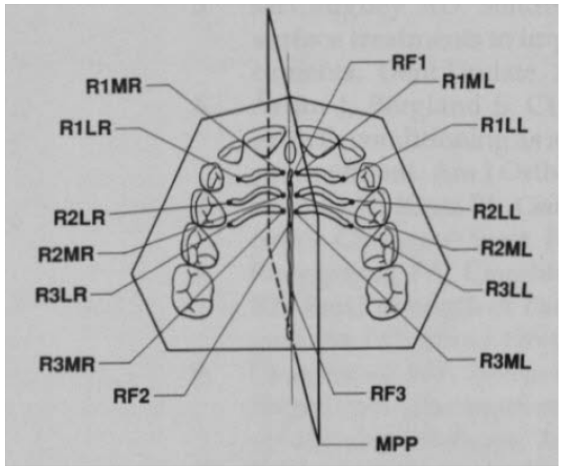

Fig. 1 of Almeida

Ex.1009, 19; Ex.1028. Ex.1005, ¶67.

"on a region of the first computer model, the region comprising a portion of the jaw other than the teeth"

The palate surface of cast 1 constitutes a region of the first computer model comprising a portion of the jaw other than teeth (*e.g.*, "palate"). Ex.1011, 632. The '661 Patent discloses that palatal rugae is a "region" of the jaw other than teeth. Ex.1001, 13:49-52. The palate includes "at least a non-tooth portion of the jaw" (under the ALJ's construction) because the palate (and palatal rugae) are not teeth. Exs.1028-1030; Exs.1009, 1016. Ex.1005, ¶68

Commer's palate surface of cast 1 is a "portion" (Petitioners' construction) and an "area" (ALJ's and Align's constructions). This is because the palate surface of cast 1 does not constitute the entire jaw (*e.g.*, the palate does not include teeth). Ex.1028; Ex.1016, 43, Fig. 1. The '661 Patent discloses that palatal rugae constitute an "area". Ex.1001, 2:41-46 ("rugae area"). Ex.1005, ¶69.

5. Element [1.4]: identifying a corresponding reference point on a corresponding region of the second computer model for each point identified on the first model;

Commer discloses Element [1.4]. Ex.1005, ¶70.

Commer discloses identifying a corresponding reference point on a corresponding region of the second computer model (*e.g.*, points of the palate point cloud associated with the palate surface of cast 2) for each point identified on the first model (*e.g.*, surface-surface matching uses "each individual point" in the two clouds). Ex.1011, 632. Ex.1005, ¶71.

"identifying a corresponding reference point"

Commer discloses identifying a corresponding reference point (*e.g.*, points on a segmented palate surface of cast 2). Ex.1011, 632. Like the reference points of cast 1 in Element [1.3], the corresponding reference points of cast 2 are identified during the surface-surface matching. *See* Element [1.3]. Like the reference points of cast 1 in Element [1.3], the corresponding reference points of cast 2 satisfy "reference point" under all constructions. Ex.1005, ¶72.

The surface-surface matching uses points from the palate point clouds ("cloud 1 and 2") of the corresponding palate surfaces. Ex.1011, 632. The reference points on the segmented palate surface of cast 2 "correspond" to the reference points on the segmented palate surface of cast 1 because for each reference point identified in the palate surface of cast 1, a corresponding reference point is identified in the palate surface of cast 2 in order to conduct the minimization procedure. *Id.* ("each individual point in cloud one and two"). Ex.1005, ¶73.

"on a corresponding region of the second computer model for each point identified on the first model"

Commer discloses performing a surface-surface matching of the region of the first model (*e.g.*, segmented palate surface of cast 1) with the corresponding region of the second model (*e.g.*, segmented palate surface of cast 2). Ex.1011, 632. Commer's palate surface of cast 2 satisfies the claimed "region" under all constructions for the same reasons discussed above concerning Commer's palate surface of cast 1 in Element [1.3]. The palate surface of cast 2 "corresponds" to the palate surface of cast 1 because they represent like surfaces (the palate) and are matched in step 1 of Commer's three-step process, discussed below. *Id.* Ex.1005, ¶74.

6. Element [1.5]: matching the region of the first computer model with the corresponding region of the second computer model, using the identified reference points;

Commer discloses Element [1.5]. Ex.1005, ¶75.

Commer discloses matching the region of the first computer model with the corresponding region of the second computer model (*e.g.*, "[t]he surface of the palate of cast 2 was matched to the surface of the reference cast 1"), using the identified reference points (*e.g.*, "surface-surface matching" technique uses "each individual point in cloud one and two"). Ex.1011, 632. Ex.1005, ¶76.

"matching the region of the first computer model with the corresponding region of the second computer model"

Commer conducts a three-step process for determining tooth movement. Ex.1011, 632. The first step matches palate surfaces of casts 1 and 2:

> 1. The surface of the palate of cast 2 was matched to the surface of the reference cast 1, giving a set of three translations and three rotations.

Id. Commer discloses "the surface of the palate" of cast 2 is matched to "the surface" of reference cast 1. *Id.* It is clear from Commer that the palate surface of cast 2 is matched to the palate surface of cast 1 for three reasons. First, the palate surface of cast 1 corresponds to the palate surface of cast 2 (*i.e.*, both are the palate surfaces of the models), and Commer seeks to match corresponding surfaces of the models (*e.g.*, "surface-surface matching"). Second, the segmentation creates point cloud segments for palates and teeth. *Id.* Because surfaces are generated from these segments point clouds, a segmented palate surface for cast 1 is generated and a corresponding segmented palate surface for cast 2 is also generated, which can only correspond to the segmented palate surface for cast 1. Third, in Step 2 of Commer's process (conducted after Step 1), Commer discloses the palate surfaces of the two models have already been matched. *Id.* ("Now, ***palates and teeth*** of both casts were in a common reference frame" (emphasis added)). Ex.1005, ¶77.

"matching ... using the identified reference points"

The first step of Commer's three-step process matches the region (palate surface of cast 1) with the corresponding region (palate surface of cast 2) "using the identified reference points." Ex.1011, 632 (*e.g.*, surface "was matched" in step 1). As explained above for Elements [1.3] and [1.4], some or all of the corresponding points on the palate surfaces of casts 1 and 2 satisfy the claimed "identified reference points." The first step of Commer's three-step process uses the "surface-surface matching" technique described earlier in Commer because the first step matches palate *surfaces*, thereby referring to Commer's "surface-surface" matching technique. *Id.*, 632. This is also because the first step of Commer's three-step process produces "three translations" and "three rotations," which refer to the three translational parameters (X,Y,Z) and the three rotational parameters (ϕ,Θ,Ψ) produced as a result of performing the "surface-surface" matching. *Id.* In the "surface-surface" matching, distances between "each individual point in cloud one and two" are determined:

> The translational (X, Y, Z) and the rotational (ϕ, Θ, Ψ) parameters of the movement can be determined by a numerical superimposition of two point clouds. This is equivalent to the minimization function $f(X, Y, Z, \phi, \Theta, \Psi)$ that defines the distance between the point clouds by the sum

> of the distances of ***each individual point in cloud one and two***. The process is called ***surface-surface matching*** [16] and was implemented using an iterative procedure. … The surface of the palate of cast 2 was matched to the surface of the reference cast 1, giving a set of three translations and three rotations.

Id., 632 (emphasis added). In applying the "surface-surface" matching technique to Commer's first step of matching the palate surface, Commer minimizes the function describing distances between reference points on the region of the first model (points of the point cloud of the palate surface of cast 1) with corresponding points on the corresponding region of the second model (*e.g.*, points of the point cloud of the palate surface of cast 2). *Id.*, 632. Thus, matching of the palate surfaces is performed by superimposing/matching points of the point clouds of the palate surfaces. Ex.1005, ¶78.

The result of the first step of Commer's three-step process is a positioning of the region of the first computer model (*e.g.*, palate surface of cast 1) overlaid onto the corresponding region of the second computer model (*e.g.*, palate surface of cast 2). Ex.1011, Fig. 8. Another result of the first step is the creation of a transform between the palate surfaces of cast 1 and cast 2 having the appropriate translational (X,Y,Z) and rotational (ϕ,Θ,Ψ) parameters. *Id.*, 632 ("giving a set of three translations and three rotations"). Such transform (*i.e.*, the matched palate surfaces) constitutes the matched regions. Thus, for the reasons above, the first step of

Commer's three-step process (using corresponding reference points to match/position corresponding palate surfaces of casts 1 and 2) satisfies Element [1.5] under all constructions (Section VI.C.). Ex.1005, ¶79.

The '661 Patent discloses essentially the same step as the first step of Commer's three-step process. In step 480 of the Fig. 10A embodiment, picked points are used to calculate a matching transform for the rugae region of the palate:

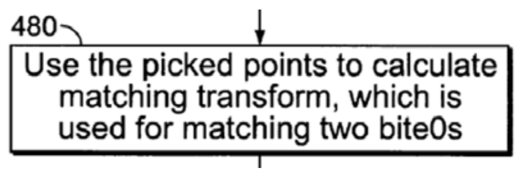

Fig. 10A of the '661 Patent (Excerpt)

Ex.1001, 9:14-23, 9:46-48. Similarly, the first step of Commer's three-step process uses picked points (*e.g.*, point clouds of the palate surfaces) to calculate a matching transform for the palate surfaces. Ex.1011, 632 ("[t]he surface of the palate of cast 2 was matched to the surface of the reference cast 1" using "surface-surface matching" technique, which uses "each individual point"). Ex.1005, ¶80.

Patent Owner may argue that the reference points must not include all of the points (*i.e.*, the entire point cloud) of the palate surface. Such a reading is inconsistent with the '661 Patent, which merely provides a minimum number of reference points (3) and is open to any maximum. Ex.1001, 9:35-37, Fig. 10A ("n>=3"). Nothing in the claims or specification requires the reference points to be less than the entire palate point cloud. The claims merely require the reference points to be from a non-tooth region. *Id.*, 13:16-18. Ex.1005, ¶81.

Patent Owner may argue that the palate surface of cast 2 is not positioned with respect to the palate surface of cast 1 (under Petitioners' construction). However, Commer discloses that a second step is performed (after the first step) where the transform (*i.e.*, translational and rotational parameters) produced in the first step is applied to all teeth surfaces of cast 2 to place them in the same reference frame/coordinate system as cast 1. Ex.1011, 632. Fig. 8b depicts the result of the second step:

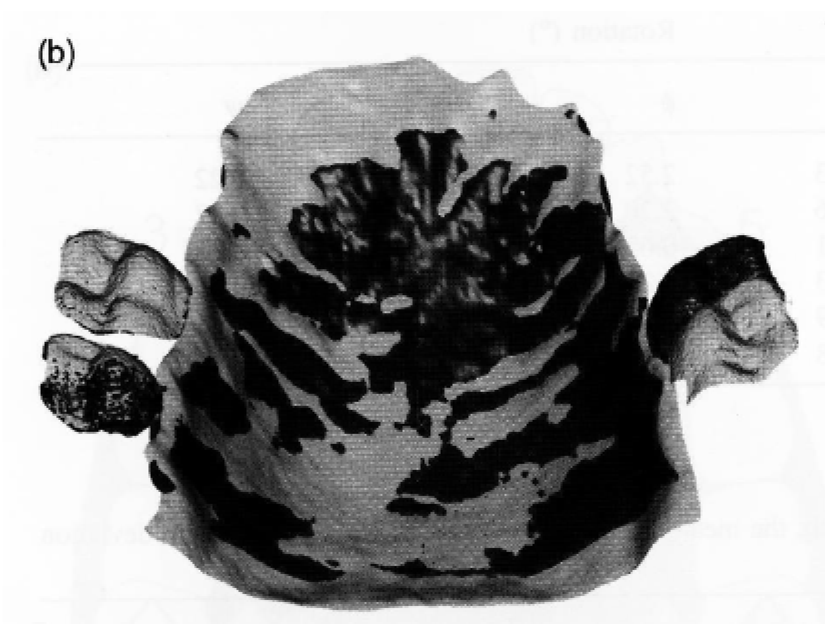

Fig. 8b of Commer

As is readily apparent, the palate surface of cast 2 is positioned with respect to the palate surface of cast 1. Because the second step involves positioning of only the teeth surfaces (*i.e.*, not the palate surfaces), the palate surfaces are already positioned as a result of the first step. Further, the segmented palate surfaces are shown as positioned (*e.g.*, overlaid) in Fig. 8b and, thus, are matched. Ex.1005, ¶82.

7. Element [1.6]: matching the first and second computer models as a whole, using the matched regions; and

Commer discloses Element [1.6]. Commer satisfies Element [1.6] under two different rationales, discussed below. Ex.1005, ¶83.

First Rationale: Step 2 of Commer satisfies Element [1.6]

Commer discloses matching the first and second computer models (*e.g.*, cast 1 and cast 2) as a whole, using the matched regions. Ex.1011, 632 (step 2). Ex.1005, ¶84.

"matching the first and second computer models as a whole"

In the second step of Commer's three-step process, the transform obtained in the first step is applied to all teeth surfaces of cast 2 to place them in the same reference frame/coordinate system as cast 1:

> 2. A transformation using these parameters was applied to the teeth of cast 2. Now, palates and teeth of both casts were in a common reference frame. The result of moving the surfaces of the second cast into the coordinate system of the first one is shown in Fig. 8b. The movement of the right molar can be recognized by the offset of the lighter molar surface with respect to the darker one and more or less stable positions of the reference teeth on the left side.

Ex.1011, 632. Fig. 8b depicts the result of performing the second step, reproduced above. *Id.* The first and second models (*e.g.*, casts 1 and 2) are matched as a whole as a result of the second step because all of the teeth and palate surfaces of casts 1 and 2 have been matched/positioned as a result of the second step. *Id.* The palate surfaces are already matched in the first step, and the matching/positioning of the teeth surfaces in a common coordinate system in the second step completes the matching/positioning of casts 1 and 2, thus resulting in matching the models "as a whole." *Id.* Ex.1005, ¶85.

"using the matched regions"

The matching of the teeth surfaces (which results in the first and second computer models being matched as a whole) uses the matched regions because such matching uses the transformation (*i.e.*, the translational (X,Y,Z) and rotational (ϕ,Θ,Ψ) parameters) produced in the first matching step wherein the regions (*e.g.*, palate surfaces) are matched. Ex.1011, 632. Matching the regions (in Element [1.5]) results in the transformation, and the transformation (which constitutes the "matched regions") is then used to match the teeth surfaces, which results in the models being matched as whole (in Element [1.6]). *Id.* Ex.1005, ¶86.

The '661 Patent discloses essentially the same step as the second step of Commer's three-step process. In 480 of Fig. 10A, the '661 Patent discloses that a transform generated from matching picked points is used to match the models ("two bite0s"):

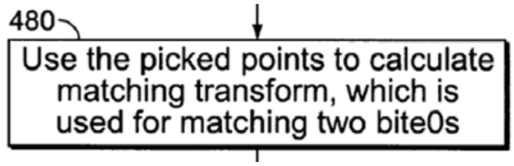

Fig. 10A of the '661 Patent (Excerpt)

Ex.1001, 9:14-23, 9:46-48. The second step of Commer's three-step process uses a transform generated from matching regions to match casts 1 and 2 as a whole. Ex.1011, 632. Ex.1005, ¶87.

In the ALJ's construction of Element [1.5], the ALJ cited the '661 Patent's disclosure of "applying a transform" to support her interpretation of the term "matching." Ex.1014, 15. Thus, the term "matching" in Element [1.5] under the ALJ's construction encompasses applying a transform. *Id.* The application of the transform in the second step of Commer's three-step process satisfies "matching." Ex.1005, ¶88.

<u>Second Rationale: Step 3 of Commer satisfies Element [1.6]</u>

Commer discloses matching the first and second computer models (*e.g.*, cast 1 and cast 2) as a whole, using the matched regions. Ex.1011, 632 (step 3). Ex.1005, ¶89.

"matching the first and second computer models as a whole"

In the third step of Commer's three-step process, Commer discloses "final ***matching*** procedures of all transformed teeth of cast 2 to the corresponding teeth of cast 1 deliver movement parameters (X, Y, Z, ϕ, Θ, Ψ) from the functional minimization for each individual molar." Ex.1011, 632 (emphasis added). The movement parameters are a determination of the position of the first computer model relative to the second computer model. *See*, *e.g.*, Ex.1001, claim 4 ("translation, rotation"). The determination of the transform in the third step of Commer's three-step process satisfies "matching." Ex.1005, ¶90.

Commer's "final" matching procedures result in the first and second models (*e.g.*, casts 1 and 2) being matched as a whole. Ex.1011, 632. This is because the final matching procedures of teeth surfaces in step 3 complete the matching of casts 1 and 2 and result in the models being matched as a whole. *Id.* Ex.1005, ¶91.

"using the matched regions"

The matching of casts 1 and 2 as a whole is performed using the matched palate surfaces (matched regions), because the final matching procedures use the common frame/coordinate system created by matching the palate surfaces (matched regions). Ex.1011, 632. The matching of the teeth ("each individual molar") uses the minimization function between points on the teeth surfaces of casts 1 and 2. *Id.* Commer also discloses that the matching of teeth uses the previously matched regions (*e.g.*, the transform determined from comparing the palate surfaces), which brought the teeth surfaces of casts 1 and 2 into the same reference frame/coordinate system. *Id.* Thus, Commer's final matching procedures use the matched regions (matched palate surfaces). Nothing in the claims require that the matching of the models as a whole *only* use the matched regions. Ex.1005, ¶92.

8. Element [1.7]: calculating positional differences between the teeth in their initial positions and the teeth in their positions in the second computer model, using the matched regions as non-moving reference regions.

Commer discloses Element [1.7]. Ex.1005, ¶93.

Commer discloses calculating positional differences between the teeth in their initial positions and the teeth in their positions in the second computer model. Ex.1011, Fig. 8b, 632, Table 2. Commer's disclosure of Fig. 8b, the third step of Commer's three-step process, and/or Table 2 showing tooth movement reconstruction each independently show this claim feature. The positional differences for the moved tooth are depicted in Fig. 8b. *Id.*, 634. Because the positional differences are the result of applying the transform (matched regions), the depiction of the moved tooth constitutes calculated positional differences.

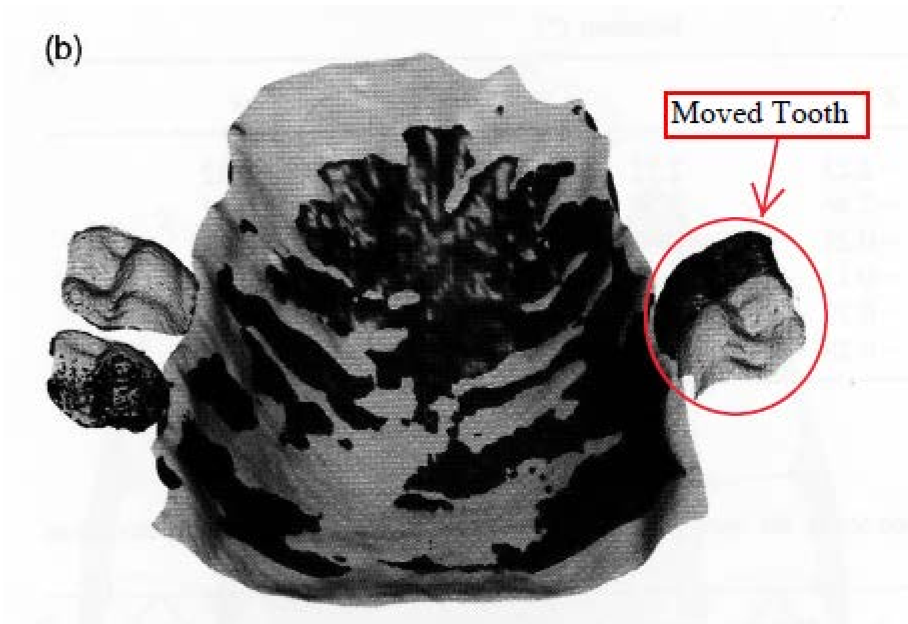

Fig. 8b of Commer (Annotated)

Numerical values for the depicted positional differences are calculated in the third step of Commer's three-step process. *Id.*, 632. Ex.1005, ¶94.

Regarding the third step, Commer discloses that "final matching procedures of ***all*** transformed teeth of cast 2 to the corresponding teeth of cast 1 deliver the ***movement parameters* (*X, Y, Z, ϕ, Θ, Ψ*)** from the functional minimization ***for each individual molar***." Ex.1011, 632, emphasis added. Thus, Commer discloses that the moved tooth of cast 2 is matched against the tooth in its original position in cast 1 by performing a minimization function. *Id*. As a result of performing this matching, translational and rotational parameters (X,Y,Z,ϕ,Θ,Ψ) for the moved tooth are generated. *Id*. Calculating translation and rotation in Commer satisfies calculating positional differences according to the '661 Patent. Ex.1001, claim 4 ("translation, rotation"). The calculated translational and rotational movement parameters represent positional differences between the tooth in its original position in cast 1 and the tooth in its moved position in cast 2. Ex.1005, ¶95.

Further, Commer's Table 2 (reproduced below) depicts results of "tooth movement" reconstructions:

Table 2
Comparison of the results of the reconstructed tooth movement for the intraoral laser scanner and the coordinate measurement table

		Translation (mm)			Rotation (°)		
		X	Y	Z	φ	θ	ψ
Molar	CoordMeasT	−5.83	−0.99	−2.23	2.52	1.02	0.22
	IOLaScan	−6.30	−0.96	−2.46	2.20	0.76	0.27
Ref. tooth 1	CoordMeasT	−0.16	0.07	−0.21	0.67	−0.70	0.66
	IOLaScan	0.25	0.08	−0.13	0.23	−0.76	0.01
Ref. tooth 2	CoordMeasT	−0.11	0.11	−0.39	0.03	−0.01	0.01
	IOLaScan	0.43	0.04	−0.28	0.32	−1.60	0.16

Table 2 of Commer

Ex.1011, 633. As shown above, Commer calculates translational and rotational (X,Y,Z,ϕ,Θ,Ψ) parameters for the moved molar, which were created using the laser scanner ("IOLaScan"). *Id.* The calculated translational and rotational movement parameters are positional differences between the tooth in its original position in cast 1 (first model) and the tooth in its moved position in cast 2 (second model). Ex.1005, ¶96.

"using the matched regions as non-moving reference regions"

The palate surfaces do not move between casts 1 and 2 (and thus are non-moving reference regions) since the only aspect of cast 2 that changes with respect to cast 1 is the movement of the molar. Ex.1011, 632 ("The first cast serves as a reference, defining the initial treatment situation, in the second one molar tooth was taken out and repositioned at a given distance to the original position."). Further, all of the teeth are transformed based on the matched palate surfaces in the second step of Commer's three-step process. *Id*. This results in the teeth being in the same plane/coordinate system. *Id.* Because the teeth are placed in the same plane/coordinate system using the matched palate surfaces, Commer effectively uses the palate surfaces as a reference landmark (non-moving reference region). Ex.1005, ¶97.

9. Claim 2: The method of claim 1, further comprising: displaying the positional differences between the teeth in the first and second models.

Commer discloses claim 1, from which claim 2 depends. *See* Section VII.A.1-8. Ex.1005, ¶98.

Commer discloses displaying the positional differences between the teeth in the first and second models. *See, e.g.*, Ex.1011, Fig. 8b (depicting positional differences), 632 ("movement parameters" for the moved tooth calculated in step 3), Table 2 (depicting reconstruction tooth movement). Ex.1005, ¶99.

As discussed above, FIG. 8b depicts the result of the second step of Commer's three-step process. Ex.1011, 632. Specifically, the models (casts 1 and 2) are matched in the same coordinate system/common reference frame based on the matching of the palate surfaces and application of that matching to the remaining teeth surfaces. *Id.*, 632; Fig. 8b. Fig. 8b is reproduced below.

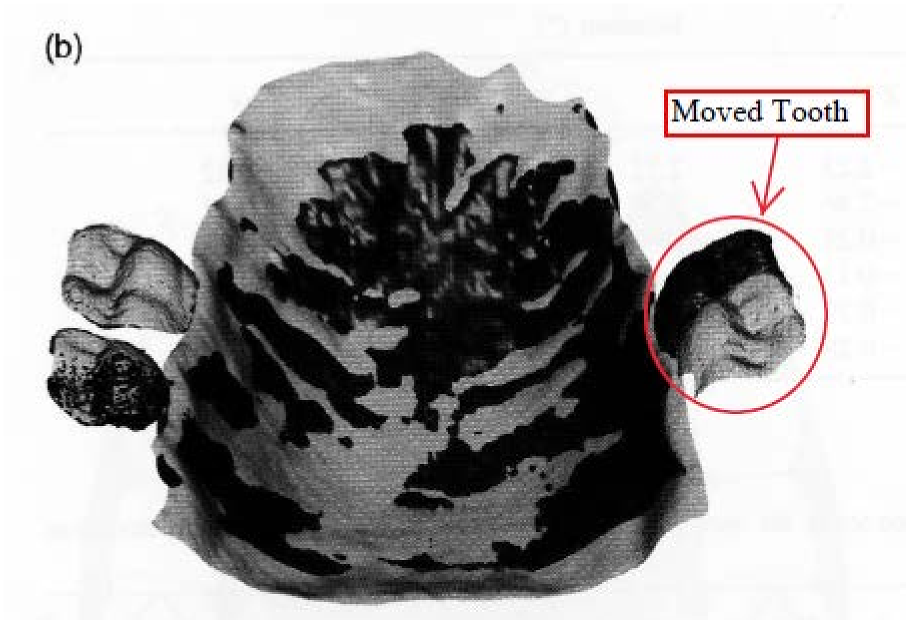

Fig. 8b of Commer (Annotated)

As shown by the red circle, the right molar is depicted as being moved. *Id.*, 632 ("The movement of the right molar can be recognized by the offset of the lighter molar surface with respect to the darker one and more or less stable positions of the reference teeth on the left side."). As also discussed, in the third step of Commer's three-step process, the translation and rotation parameters were calculated by minimizing the distance between the moved tooth in the point clouds for casts 1 and 2. *Id.* As such these parameters are numeric values that correspond to the positional difference depicted in Fig. 8b. Thus, Fig. 8b depicts the positional differences between the teeth in the first and second models. Ex.1005, ¶100. For similar reasons,

Table 2 depicts and, thus, displays tooth movement parameters. Ex.1011, 633; Ex.1005, ¶100.

Commer discloses that the scanning system includes a personal computer running control software. Ex.1011, 626, Fig. 2. Commer's personal computer has a display which displays the screen depicted in Fig. 4 (reproduced below) used in reproduction of the three-dimensional coordinates. *Id.*, 628.

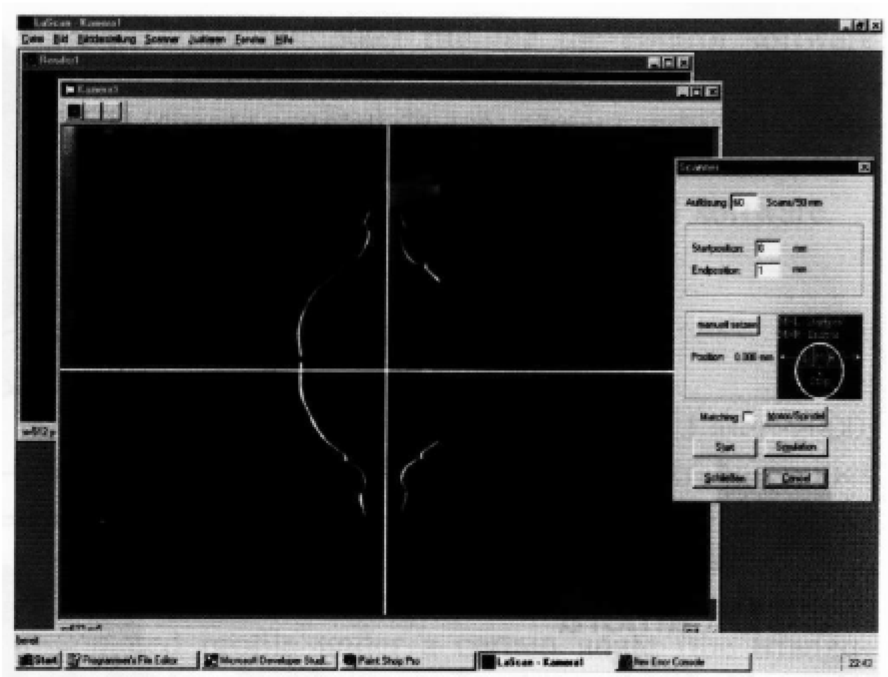

Fig. 4. Screen dump of the software with the two different views seen by the CCD camera.

Fig. 4 of Commer

Commer's personal computer is designed to depict data output from the scanner as shown in Fig. 4. A POSITA would have understood this include the positional difference data between the teeth in the first and second models produced by Commer. *See* Element [1.7]. Ex.1005, ¶101.

10. Claim 3: The method of claim 1, wherein matching the region of the first computer model with the corresponding region of the second computer model comprises: placing the first and second computer models in a single coordinate system.

Commer discloses claim 1, from which claim 3 depends. *See* Section VII.A.1-8. Ex.1005, ¶102.

As a result of performing the second step of Commer's three-step process, Commer discloses that the first computer model (*e.g.*, cast 1) and the second computer model (*e.g.*, cast 2) are placed in a single coordinate system. Ex.1011, 632 ("A transformation using these parameters was applied to the teeth of cast 2. Now, palates and teeth of both casts were in ***a common reference frame***. The result of moving the surfaces of the second cast into ***the coordinate system*** of the first one is shown in Fig. 8b.") (emphases added); Ex.1005, ¶103.

11. Claim 4: The method of claim 1, wherein calculating the positional differences comprises: calculating one or more of intrusion, extrusion, translation, rotation, angulation, or inclination of at least some of the teeth in the second computer model, relative to their initial positions in the first computer model.

Commer discloses claim 1, from which claim 4 depends. *See* Section VII.A.1-8. Ex.1005, ¶104.

Commer discloses that "final matching procedures of all transformed teeth of cast 2 to the corresponding teeth of cast 1 deliver the movement parameters (*X, Y, Z, ϕ, Θ, Ψ*) from the functional minimization for each individual molar." Ex.1011, 632. Thus, Commer discloses that teeth positions of cast 2 are calculated relative to teeth positions in cast 1 by performing a minimization function. *Id*. As a result of this matching, translational (*X,Y,Z*) and rotational (*ϕ,Θ,Ψ*) movement parameters for the moved tooth are generated. *Id*. These calculated translational and rotational movement parameters represent positional differences between the teeth in the first computer model (cast 1) and teeth in the second computer model (cast 2). Ex.1005, ¶105.

In addition, Commer discloses Table 2 (reproduced below) that depicts the results of the reconstructed tooth movement (comparing initial and final teeth positions), which also satisfies claim 4.

Table 2
Comparison of the results of the reconstructed tooth movement for the intraoral laser scanner and the coordinate measurement table

		Translation (mm)			Rotation (°)		
		X	*Y*	*Z*	*ϕ*	*θ*	*Ψ*
Molar	CoordMeasT	−5.83	−0.99	−2.23	2.52	1.02	0.22
	IOLaScan	−6.30	−0.96	−2.46	2.20	0.76	0.27
Ref. tooth 1	CoordMeasT	−0.16	0.07	−0.21	0.67	−0.70	0.66
	IOLaScan	0.25	0.08	−0.13	0.23	−0.76	0.01
Ref. tooth 2	CoordMeasT	−0.11	0.11	−0.39	0.03	−0.01	0.01
	IOLaScan	0.43	0.04	−0.28	0.32	−1.60	0.16

Table 2 of Commer

Ex.1011, 633. Ex.1005, ¶106.

12. Claim 19 (Element [19.P]): A tangible computer readable medium containing code for matching computer models of a jaw, the tangible computer readable medium comprising instructions to:

Commer discloses the preamble of claim 19. *See* Section VII.A.1. Ex.1005, ¶107.

Commer discloses a "computer-based" system which acquires and manipulates digitized dental models. Ex.1011, title, 626 ("video data [fed] into the memory of a personal computer"), 628 ("control software"), Fig. 1, Fig. 4. A POSITA would have understood that the code (*e.g.*, "software") for carrying out the processes of Commer would have been stored on a tangible computer readable medium.[5] It was well known that software is contained on a tangible computer readable medium of a computer. *See, e.g.*, Ex.1019 at 6:45-58, Ex.1018 at 13:22-35. A POSITA would have understood that the computer disclosed by Commer would include such a tangible computer readable medium containing code for performing the disclosed processes. Ex.1005, ¶108.

13. Element [19.1] load a first computer model of a jaw having teeth in initial positions;

Commer discloses Element [19.1]. *See* Section VII.A.2. Ex.1005, ¶109.

[5] The medium can be "memory and/or storage elements." Ex.1001, 12:45-50.

14. Element [19.2]: load a second computer model of the jaw, wherein positions of at least some of the teeth in the second computer model are different than the initial positions;

Commer discloses Element [19.2]. *See* Section VII.A.3. Ex.1005, ¶110.

15. Element [19.3]: identify at least one reference point on a region of the first computer model, the region comprising a portion of the model other than the teeth;

Commer discloses Element [19.3]. *See* Section VII.A.4. Ex.1005, ¶111.

16. Element [19.4]: identify a corresponding reference point on a corresponding region of the second computer model for each point identified on the first model;

Commer discloses Element [19.4]. *See* Section VII.A.5. Ex.1005, ¶112.

17. Element [19.5]: march [sic] the region of the first computer model with the corresponding region of the second computer model, using the identified reference points;

Commer discloses Element [19.5]. *See* Section VII.A.6. Ex.1005, ¶113.

18. Element [19.6]: match the first and second computer models as a whole, using the matched regions; and

Commer discloses Element [19.6]. *See* Section VII.A.7. Ex.1005, ¶114.

19. Element [19.7]: calculate positional differences between the teeth in their initial positions and the teeth in their positions in the second computer model, using the matched regions as non-moving reference regions.

Commer discloses Element [19.7]. *See* Section VII.A.8. Ex.1005, ¶115.

20. Claim 20: The medium of claim 19, further comprising instructions to: display the positional differences between the teeth in the first and second models.

Commer discloses claim 19, from which claim 20 depends. Other than the preamble, claim 20 is identical to claim 2. Commer discloses claim 20 for at least the same reasons provided concerning claim 2. *See* Section VII.A.9. Ex.1005, ¶116.

21. Claim 21: The medium of claim 19, further comprising instructions to: place two jaw impressions in a single coordinate system.

Commer discloses claim 19, from which claim 21 depends. Like claim 3, claim 21 recites placing two jaw impressions "in a single coordinate system." Commer discloses claim 21 for at least the same reasons provided concerning claim 3. *See* Section VII.A.10. Commer discloses that the computer models are of a "jaw." Ex.1011, 632; Ex.1001, 9:14-17, 9:32-34 ("model" and "impression" used interchangeably). Ex.1005, ¶117.

22. Claim 22: The medium of claim 19, further comprising instructions to: calculate one or more of intrusion, extrusion, translation, rotation, angulation, or inclination of at least some of the teeth in the second computer model, relative to their initial positions in the first computer model.

Commer discloses claim 19, from which claim 22 depends. Other than the preamble, claim 22 is virtually identical to claim 4. Commer discloses claim 22 for at least the same reasons provided concerning claim 4. *See* Section VII.A.11. Ex.1005, ¶118.

B. Claims 1-4, 6, 19-22, and 26 Would Have Been Obvious Based on the Combined Disclosures of Commer and Ashmore. [Ground 2]

Section 1 below provides examples of where each element of the challenged claims is found in the prior art. Section 2 below provides an explanation of why the challenged claims as a whole would have been obvious.

1. Reference to Where the Elements of Claims 1-4, 6, 19-22, and 26 are Found in the Prior Art

The following sections provide reference to where the elements of the challenged claims are found in the prior art, in light of the constructions set forth in section VI.

a. Claims 1-4, 6, 19-22, and 26

Commer discloses each feature recited in claims 1-4 and 19-22. *See* Section VII.A. Discussed below are additional prior art disclosures which support Ground 2. Ex.1005, ¶122.

Ashmore discloses using points on palatal rugae to match dental models

Assuming (incorrectly) Commer does not disclose a point on a stable anatomical structure (Petitioners' construction of "reference point") and "using the matched regions as non-moving reference regions," the combination of Commer and Ashmore discloses such features. *Id.*, ¶123.

Ashmore discloses that parts of the palate (*e.g.*, the medial palatal rugae) are substantially stable throughout a person's lifetime. Ex.1009, 19 ("specific parts (eg, medial) of the palatal rugae may be sufficiently stable to serve as an anatomic reference"). Ashmore discloses using medial palatal rugae as a reference region for superimposing serial maxillary (jaw) models to study teeth movement. *Id.*, 19 (citing Ex.1016); Ex.1016, title, abstract ("The medial rugae appear to be suitable anatomical points for the construction of stable reference planes for longitudinal cast analysis"); Ex.1009, 20 ("specific parts of the palatal rugae may be sufficiently stable to serve as an anatomic reference for superimposing serial maxillary models, despite intervening headgear … treatment."); Ex.1015. Ashmore discloses that using palatal rugae as a reference provides accurate results. Ex.1009, 28 ("The method … allowed accurate measurement of maxillary first-molar translational movement in 3 dimensions"). Ex.1005, ¶¶124-125.

Ashmore (like Commer) discloses superimposition of 3D dental models. *Id.*, 18 ("data were collected from initial and final models"), 19 ("to orient the initial (T1) models into a common frame of reference, and then to superimpose a patient's subsequent models on the T1 model"), 25 ("Sequence of Serial Maxillary Models (T1 - T14)"). Ex.1005, ¶126.

Ashmore discloses matching the region (*e.g.*, palatal rugae area from which the reference points are selected) of the first computer model with the corresponding region (*e.g.*, corresponding palatal rugae area of the second model) of the second computer model, using the identified reference points (*e.g.*, "corresponding rugae registration points"). *Id.*, 21, 19 ("unique anatomical landmarks selected on the palatal rugae"). This is because Ashmore discloses that the digitized points of the second model (*e.g.*, "subsequent model") which include the corresponding rugae registration points of the second model are superimposed on the first model (*e.g.* "T1 model" or any model obtained from an earlier cast):

> Once the T1 models of all subjects were oriented in a similarly defined spatial frame of reference, each subject's subsequent models were superimposed on the T1 model with a least-squares rotational fit (Procrustes) with palatal rugae points as the registration landmarks. ***Digitized data points from subsequent models were translated and rotated to minimize the sum of squared Euclidean distances between corresponding rugae registration points.*** The algorithm used to achieve the rigid transformation was adapted from that described by Rohlf. Only rigid transformations (without scaling) were used ***to achieve the best-fit superimposition***.

Id., 21 (emphases added). Ex.1005, ¶127.

As explained in Section VII.B.2., it would have been obvious to a POSITA to use the medial rugae region as the non-moving reference region in Commer's matching technique, in view of Ashmore. For example, rather than using the entire palate to match the models, the medial rugae region of the palate would be used in the obvious combination. *Id.* A POSITA would understand that, in the combination of Commer and Ashmore, the reference point would be on the medial rugae region of the palate. *Id.* Thus, the combination of Commer and Ashmore satisfies a "reference point" under Petitioners' construction of "a point on a stable anatomical structure" (Elements [1.3], [1.4], [19.3], [19.4]). Because the medial rugae region of the palate is stable throughout a person's lifetime and used as a reference, the matched rugae are "non-moving reference regions" (Elements [1.7], [19.7]). Ex.1009, 19; Ex.1005, ¶128.

It was well known to "load" computer models

Assuming (incorrectly) Commer does not disclose "loading" a computer model, it was well known that "loading" data into a computer workstation allows the data to be accessed by software. Ex.1027, 39:7-43:27 (the program downloads the 3D data file to utilize the file); Ex.1012 at ¶[0120] (data is "loaded into the workstation, and accessed from the treatment planning software"). Ex.1005, ¶129.

b. Claim 6: The method of claim 1, wherein the matched region is selected from the group consisting of one or more rugae on a palate of the jaw, gingiva, bone, a restoration and an implant.

The combination of Commer in view of Ashmore discloses claim 6. Claim 1 (from which claim 6 depends) is unpatentable for the reasons discussed above. As discussed in Section VII.B.1.a., Ashmore discloses selecting medial palatal rugae (which satisfies "one or more rugae on a palate of the jaw") as the matched region. Ex.1005, ¶130.

c. Claim 26: The medium of claim 19, wherein the watched [sic] region is selected from the group consisting of one or more rugae on a palate of the jaw, gingiva, bone, a restoration, and an implant.

As explained above, Commer discloses claim 19, from which claim 26 depends. Other than the preamble, claim 26 is virtually identical to claim 6.[6] Commer and Ashmore disclose claim 26 for at least the same reasons provided above concerning claim 6. *See* Section VII.B.1.a. Ex.1005, ¶131.

2. Explanation of Why Claims 1-4, 6, 19-22, and 26 Would Have Been Obvious

Patent Owner may argue that Commer does not disclose one or more of the following:

(i) a "point on a stable anatomical structure" under Petitioners' construction of "reference point" (Elements [1.3], [1.4], [19.3], [19.4]); "using the matched regions as non-moving reference regions" (Elements [1.7], [19.7]); and the matched region "is selected from the group consisting of one or more rugae on a palate of the jaw…" (claims 6, 26);

(ii) "loading" a computer model (Elements [1.1], [1.2], [19.1], [19.2]);

(iii) "matching the region … using identified reference points" under Petitioner's construction (Elements [1.5], [19.5]);

[6] The term "watched" in claim 26 is understood as "matched".

(iv) "A tangible computer readable medium … comprising instructions to…" (Element [19.P]); and "displaying positional differences between the teeth in the first and second models" (claims 2, 20).

Such arguments are untenable. The alleged missing elements were well-known and a POSITA would have had ample reasons to modify Commer to arrive at the claimed subject matter. Ex.1005, ¶132.

a. It would have been obvious to use points on palatal rugae as a non-moving reference region in view of Ashmore (claims 1-4, 6, 19-22, 26)

Both Commer and Ashmore seek accurate matching

Concerning (i), it would have been obvious to a POSITA to modify Commer to use reference points on the medial palatal rugae of the palatal surface (which are points on a stable anatomical structure under Petitioners' construction of "reference point"), in view of Ashmore (Elements [1.3], [1.4], [19.3], [19.4]). It would have also been obvious to modify Commer's matching technique to use the medial palatal rugae of the palatal surface as the non-moving, matched reference region, in view of Ashmore ([1.7], [19.7]; claims 6, 26). There are several reasons why a POSITA would have modified Commer in view of Ashmore. Ex.1005, ¶133.

A POSITA would have been motivated to modify Commer's method to select the palatal rugae (*e.g.*, medial palatal rugae) as the region in view of Ashmore. This is because a POSITA would have recognized that doing so would improve the accuracy of Commer's matching of the surfaces for casts 1 and 2. Both Commer and Ashmore recognize the desirability of obtaining accurate tracking of tooth movement. Ex.1011, 625 ("an accurate and easy to perform method for retrieving three-dimensional data of tooth positions and orientations is of highest interest."), 632 ("test[ing] the accuracy of the whole matching process"), 634 ("The results on the accuracy of our laser scanner prototype seem to be very promising"); Ex.1009, 26 ("quantify the accuracy of the superimposition of the rugae reference points"), 28 ("accurate measurement"). Ex.1005, ¶134.

Ashmore teaches using the medial palatal rugae as a reference region to match models because the medial palatal rugae are stable. Ex.1009, 29 ("The shape of the palatal vault and the medial portions of the palatal rugae are rather stable throughout the development of the dentition. Palatal rugae retain their shape and pattern throughout a person's lifetime…."), 27-28 ("greater statistical emphasis can be placed on rugae points known to be the least susceptible to treatment-induced changes (eg, medial aspects)"), 19; Ex.1016. Thus, Ashmore teaches that superimposition of computer models of a jaw are made more accurate by using the medial palatal rugae because medial palatal rugae are stable. Also, influence by unstable portions of the palate can be mitigated. *Id.* Ex.1005, ¶135.

Patent Owner may argue that Ashmore's matching technique provides less accurate results than Commer's matching technique. Such an argument is untenable.

The obvious combination in this petition does not incorporate Ashmore's specific computational matching technique to satisfy claim limitations. Rather, Ashmore is relied on for its teaching to use the medial palatal rugae as a stable reference region, and that stable regions such as medial palatal rugae provide improved matching accuracy in comparison with using the palate as a whole. In the obviousness combination, Commer is modified to implement this feature in its matching technique, which improves its accuracy. *Id.*, ¶136.

Both Commer and Ashmore disclose using a reference anatomical structure as the basis for matching initial and subsequent models

Both Commer and Ashmore are directed to the same field of endeavor: scanning systems for tracking tooth movement/changes. *See, e.g.*, Ex.1011, abstract ("Applications in orthodontics were demonstrated … describing tooth movement"), Fig. 1, 632-634; Ex.1009, abstract ("superimposing 3-dimensional data obtained from selected landmarks on … dental casts to describe … molar movement"), 19-21. Any argument by Patent Owner that a POSITA would not have looked to Ashmore to modify Commer is untenable. This overlooks the close similarities between Commer and Ashmore, *i.e.*, both relate to the same field of endeavor, address the same general problem in registering models (*e.g.*, assessing changes between initial and subsequent models), and provide similar solutions (*e.g.*, using anatomical regions of the models as reference regions to compare initial and subsequent models and calculate tooth movement). A POSITA would have recognized that Ashmore's technique for matching initial and subsequent models to measure tooth movement, *e.g.*, using a stable anatomical region (*e.g.*, media palatal rugae), would be highly relevant and applicable to Commer's technique for measuring tooth movement using the palate. Ex.1005, ¶¶137-138.

Additionally, a POSITA would have been motivated to use only the medial rugae of the palate, rather than the palate as a whole, as the reference region in Commer's method in order to reduce the processing time for performing the method. Ex.1012, ¶[0072] (reducing processing time is desirable). Because the medial rugae of the palate is smaller than the palate, the number of points in a point cloud segment for the medial rugae would be less than that of the palate as a whole. In Commer's first step of its three-step process, the minimization of distance between corresponding points would require less time because there are fewer corresponding points. *Id.* Ex.1005, ¶139.

A POSITA would have adapted Commer's technique in view of Ashmore to use the stable medial rugae region, rather than the entire palate, as the reference region

In using Ashmore's stable medial rugae reference region as the reference region in Commer's matching method, a POSITA would have segmented the stable medial rugae region from the palate to create a point cloud segment specific to the stable medial rugae region and a point cloud segment specific to the remainder of the palate, generate a medial rugae surface and a remainder palate surfaces from these point clouds, match the medial rugae surface regions of the palates of casts 1 and 2 to obtain a transform of translational and rotational parameters (first step of Commer's three-step process), apply this transform to the remaining teeth and palate surfaces (the second step of Commer's three-step process), and perform the final step of Commer's three-step process. Ex.1005, ¶140. As a result, Commer's method as modified in view of Ashmore uses the stable medial rugae region of the palate rather than the palate as a whole. *Id.*, ¶140.

A POSITA would have had a reasonable expectation of success in utilizing the stable medial rugae region of the palate as the reference anatomical structure as taught by Ashmore instead of the palate as a whole as taught by Commer. *Id.*, ¶141. This is because the palate described in Commer already includes the medial rugae region described in Ashmore (Ex.1009, 20-21). *Id.*, ¶141. This is also because both Commer and Ashmore describe similar matching procedures generally – namely, matching models or segments thereof using points corresponding to a reference anatomical structure. Ex.1011, 632; Ex.1009, 20-21. These similarities are discussed above. The modification would yield predictable results because Commer already discloses segmenting data sets to produce segmented point clouds used to generate surfaces. As a result, a POSITA would have expected that use of the medial rugae region of the palate as taught by Ashmore as the reference anatomical structure instead of the palate as a whole as in Commer's matching method would yield a predictable result, *i.e.*, matching of the models using the stable medial rugae regions of the palate. Virtual modeling is a predictable art and, as such, using only a portion of the palate (*e.g.*, the rugae) rather than the palate as a whole to match models would similarly be predictable. Ex.1005, ¶141.

There are many other reasons why a POSITA would have modified Commer in view of Ashmore

A POSITA would have recognized that Ashmore provides a simple, predictable, and effective way to improve the matching technique of Commer: utilize a specific part of the palate (*e.g.*, medial palatal rugae) instead of the entire palate as the non-moving reference region. The challenged claims are no more than an obvious combination of prior art elements (*e.g.*, the use of the medial palatal rugae as a stable reference region as taught by Ashmore) according to known methods (*e.g.*, Commer's matching technique) to yield predictable results (using the medial palatal rugae instead of the entire palate would have been predictable). The challenged claims amount to the obvious use of a known technique (*e.g.*, the use of the medial palatal rugae as a stable reference region as taught by Ashmore) to improve a similar method and system (*e.g.*, Commer's matching technique and system) in the same way. Ashmore provides a comparable matching technique to Commer (*e.g.*, both match initial and subsequent computer dental models utilizing non-teeth regions) but improves upon Commer's technique by focusing on a specific part of the palate (*e.g.*, medial palatal rugae) to yield predictable results (again, using the medial palatal rugae instead of the entire palate would have been predictable). Both Commer and Ashmore describe minimizing distance between points. Ex.1011, 632 ("minimization of … distance between point clouds by the sum of distances of each individual point"); Ex.1009, 21 ("Digitized data point from subsequent models were translated and rotated to minimize the sum of squared Euclidean distances between corresponding rugae registration points."). The challenged claims amount to the simple substitution of one known element (the entire palate in Commer) for another (a specific part of the palate, *e.g.*, medial palatal rugae disclosed by Ashmore) to obtain predictable results. Substituting the entire palate (as in Commer) with the medial palatal rugae (as in Ashmore) would have yielded predictable results given the fact that the entire palate in Commer and the medial palatal rugae in Ashmore are used for the same general purpose (*e.g.*, as non-tooth references). Ex.1005, ¶142.

Assuming (incorrectly) that the various features of Commer referred to herein relate to different embodiments of Commer (or the various features of Ashmore referred to herein relate to different embodiments of Ashmore), a POSITA would have had ample reasons to combine the prior art disclosures with a reasonable expectation of success given the overall similarities of the techniques and systems described in the prior art, as discussed above. Ex.1005, ¶143.

b. It would have been obvious to "load" computer models (claims 1-4, 6, 19-22, 26)

Concerning (ii), assuming (incorrectly) Commer does not disclose "loading" a computer model, it was well known that "loading" data into a computer workstation allows the data to be accessed by software. Ex.1027, 39:7-43:27 (the program downloads the 3D data file to utilize the file); Ex.1012 at ¶[0120] (data is "loaded into the workstation, and accessed from the treatment planning software"). Since Commer discloses accessing the computer model by software (Ex.1011, 628), it would have been obvious to "load" the computer model onto a computer to allow software to access the computer model. A POSITA would have had a reasonable expectation of success given the high level of predictability associated with loading data on a computer, and that Commer already provides the data and computer for such loading. *Id.* Ex.1005, ¶144.

c. It would have been obvious to position the palate surfaces in the first step of Commer's process (claims 1-4, 6, 19-22, 26)

Concerning (iii), assuming (incorrectly) Commer does not disclose matching (*i.e.*, "positioning…" under Petitioners' construction) the palate surfaces of casts 1 and 2 in Commer's first step, a POSITA would have been motivated to do so. Commer already visualizes the models (*e.g.*, cast 1, cast 2) at various stages of its 3-step process (*e.g.*, in Fig. 8a-8c). Visualizing the matched palate surfaces in step 1 would provide the user with visual confirmation of the matched palate surfaces before moving on to subsequent steps of Commer's process. Since Commer discloses that the palate surfaces are already positioned in Fig. 8b (*i.e.*, at the end of the second step), there are only two possibilities for positioning of the palate surfaces – either during the first step or during the second step. Given the limited number of possibilities (two), it would have been obvious to position the palate surfaces during the first step to accomplish the disclosed positioning. A POSITA would have had a reasonable expectation of success given the high predictability associated with computer visualization. Ex.1005, ¶145.

d. Claims 2 and 20 (and [19.P]) would have been obvious

It would have been obvious to modify Commer to display positional difference data

Concerning (iv), assuming (incorrectly) Commer does not disclose claims 2 and 20, Commer provides data of the positional differences between the teeth in their positions in the first and second models (*e.g.*, casts 1 and 2). *See* Element [1.7]. As explained above, Commer's system includes a personal computer running control software, where the computer has a display (Fig. 4) for displaying dental model data. Ex.1011, 626, 628, Fig. 2. Commer's personal computer is designed to depict data output from the scanner as shown in Fig. 4, and Fig. 8b of Commer shows a visual representation of data after analysis has been performed by the personal computer. *Id.*, 632-633. Commer discloses Table 2 that includes movement parameters of teeth of the first and second models ("Molar", "Ref. tooth 1", "Ref. tooth 2"). A POSITA would have been motivated to display Fig. 8b (on a computer screen) because doing so would allow the user to view the tooth movements and progress of Commer's technique (Ex.1011, 632), especially for orthodontic applications (*Id.*, 633). For similar reasons, a POSITA would have been motivated to display movement parameters calculated in step 3 and Table 2 to inform the user/orthodontist of the calculated values. *Id.* A POSITA would have had a reasonable expectation of success given the predictable nature of computer visualization, and that Commer already provides the data and computer screen for such visualization. Ex.1005, ¶146.

Additionally, a POSITA would have been motivated to display the positional differences as calculated in step 3, depicted in Fig. 8b, and/or provided in Table 2 at least because it is commonplace in the art to display such position differences on a screen. Ex.1012, ¶[0143] (a point on the tooth in the current model is selected, and the model of the tooth at the original malocclusion is overlaid on the screen. The superposition of the two teeth allows the user to view the change in position that has occurred. The measurement marker features described earlier allow the user to quantify precisely the amount of movement."), ¶¶[0114]-[0116], Fig. 10. Ex.1005, ¶147.

Claim 20 recites: "The medium of claim 19, further comprising instructions to: display the positional differences between the teeth in the first and second models." Commer discloses claim 19, from which claim 20 depends. Other than the preamble, claim 20 is identical to claim 2. Commer renders obvious claim 20 for at least the same reasons provided above concerning claim 2. *See* Section VII.B.1. Ex.1005, ¶148.

It would have been obvious to modify Commer to conduct its processes using a computer

Assuming (incorrectly) Commer does not disclose Element [19.P], it would have been obvious to conduct the processes disclosed by Commer (*e.g.*, the segmentation and three-step process) for the reasons discussed above concerning claims 2 and 20. Commer discloses a "computer-based" system (title) and provides the computer for carrying out the processes described therein. It would have been obvious to conduct the processes described therein using instructions stored in the tangible computer readable medium because Commer suggests doing so (the data manipulated in Commer's process (*e.g.*, point clouds, surfaces) is digital data intended to be manipulated by a computer), and Commer provides a system (including a computer, Fig. 1) for carrying out such computer-based processes. A POSITA would have had a reasonable expectation of success given the high level of predictability associated with storing instructions on a tangible computer readable medium and using same. Ex.1005, ¶149.

VIII. OTHER CONSIDERATIONS

A. Any Purported Secondary Considerations Evidence Does Not Overcome the Strong Evidence of Obviousness

Petitioners are not aware of any secondary considerations evidence bearing any nexus to the claims. Any secondary considerations evidence Patent Owner may offer in this proceeding would be insufficient to overcome the strong evidence of obviousness of the challenged claims, explained above.

B. Discretion to Institute

The PTAB should not deny this Petition under § 314(a). The ’661 Patent has not been challenged in any prior AIA trial proceeding. This Petition is not a “follow-on” petition as was the case in *General Plastic*.

Events in the Delaware litigation and ITC investigation do not warrant denial. The IPR statutory framework permits filing within one year of service of a complaint. The Delaware litigation is stayed and trial has not been scheduled. Exs.1024, 1025. This Petition challenges claims 1-4, 6, 19-22, and 26, whereas only claims 1-2 and 19-20 are at issue in the ITC investigation. Ex.1026, 1. The fact that this Petition challenges a different set of claims than is at issue in the ITC investigation weighs against denial. *See, e.g., 3Shape A/S v. Align Tech., Inc.*, IPR2019-00157, Paper 9 (PTAB Jun. 5, 2019), 38 (“We agree with Petitioner … that differing claim sets is a factor that weighs against exercise of our discretion under § 314(a) to deny institution based on the ITC investigation.”).

The ITC cannot resolve a challenge to patent validity because the ITC does not have authority to invalidate a patent. *Bio-Tech. Gen. Corp. v. Genentech, Inc.*, 80 F.3d 1553, 1564 (Fed. Cir. 1996); *Tex. Instruments Inc. v. Cypress Semiconductor Corp*., 90 F.3d 1558, 1569 (Fed. Cir. 1996); *Wirtgen America, Inc. v. Caterpillar Paving Products Inc.*, IPR2018-01201, Paper 13 (PTAB Jan. 8, 2019), 12 ("[T]he ITC does not have authority to invalidate a patent."); *Samsung Elecs. Co., Ltd. v. BiTMICRO LLC*, IPR2018-01545 (PTAB Mar. 7, 2019), 24.

Thus, denying institution due to the Delaware litigation or the ITC investigation does not promote the efficient administration of justice.

Denial under § 325(d) is not warranted. Neither Commer nor Ashmore was considered during prosecution of the '661 Patent, let alone applied in a rejection.

Denial under § 325(d) is not warranted when considering the six *Becton, Dickinson* factors. Concerning factors (1) and (4), neither reference applied by the examiner (Sachdeva and Snow) was cited as disclosing the use palatal rugae as a stable reference point for comparing initial and subsequent 3D tooth models, as taught by Commer alone or in view of Ashmore. Neither Sachdeva nor Snow was cited as disclosing conducting a second matching step of matching models as a whole, as taught by Commer. Concerning factor (2), the disclosures of Commer and Ashmore discussed above are not cumulative to Sachdeva and Snow. Concerning factor (3), the examiner neither considered nor applied Commer alone or in combination with Ashmore during prosecution. Concerning factor (5), there is no record that the Examiner substantively evaluated Commer alone or in combination with Ashmore. Petitioners have shown there is a reasonable likelihood that the challenged claims are anticipated by Commer or are unpatentable over Commer alone or in view of Ashmore. Concerning factor (6), Petitioners are unaware of any additional evidence or facts that warrant denial.

IX. CONCLUSION

Petitioners have shown a reasonable likelihood of success on the merits. Therefore, this Petition should be granted and the Board should institute trial.

Respectfully submitted,

Date: December 9, 2019

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APPENDIX A - LIST OF EXHIBITS

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 7,156,661, issued on January 2, 2007 to W. Choi *et al.* (“the ’661 Patent”)
1002	File History of U.S. Patent No. 7,156,661
1003	U.S. Patent No. 7,077,647, issued on July 18, 2006 to W. Choi *et al*. (“the ’647 Patent”)
1004	File History of U.S. Patent No. 7,077,647
1005	Declaration of Dr. Eli Saber
1006	*Curriculum Vitae* of Dr. Eli Saber
1007	Declaration of Sylvia D. Hall-Ellis
1008	*Curriculum Vitae* of Sylvia D. Hall-Ellis
1009	Jennifer L. Ashmore *et al.*, “A 3-Dimensional Analysis of Molar Movement During Headgear Treatment,” American Journal of Orthodontics and Dentofacial Orthopedics, Volume 121, Number 1, January 2002, pages 18-29 (“Ashmore”)
1010	V. Jovanovski *et al.*, “Analysis of the Morphology of Oral Structures from 3-D Co-Ordinate Data,” Assessment of Oral Health: Diagnostic Techniques and Validation Criteria, Editor: R.V. Faller, Monographs in Oral Science, Editor: G.M. Whitford, Basel. Karger, 2000, Vol. 17, pp. 73-129 (“Jovanovski”)
1011	P. Commer *et al.*, “Construction and testing of a computer-based intraoral laser scanner for determining tooth positions,” Medical Engineering & Physics 22 (2000), pp. 625-635 (“Commer”)
1012	U.S. Patent Application Publication No. 2002/0010568, published on January 24, 2002 to R. Rubbert *et al.* (“Rubbert ’568”)

EXHIBIT	DESCRIPTION
1013	U.S. Patent No. 6,632,089, issued on October 14, 2003 to R. Rubbert *et al*. (“Rubbert ’089”)
1014	Order No. 36: Construing Certain Terms of the Asserted Claims of the Patents at Issue (*Markman* Claim Construction), Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, October 1, 2019
1015	The American Heritage College Dictionary, 3rd Ed., 1997, Houghton Mifflin Company, pp. 823, 839, definitions of “maxillary” and “mandibular”
1016	Marco Almeida *et al*., “Stability of the palatal rugae as landmarks for analysis of dental casts,” The Angle Orthodontist, Vol. 65, No. 1, 1995, pp. 43-48 (“Almeida”)
1017	F. James Rohlf, “Rotational Fit (Procrustes) Methods,” PROCEEDINGS OF MICHIGAN MORPHOMETRICS WORKSHOP, Ann Arbor: University of Michigan Museum of Zoology, p. 227-36 (1990) (“Rohlf”)
1018	U.S. Patent No. 5,564,113 issued on Oct. 8, 1996 to D. Bergen et al. (“Bergen”)
1019	U.S. Patent No. 6,049,743, issued on April 11, 2000 to M. Baba (“Baba”)
1020	Respondent 3Shape A/S, 3Shape Trios A/S, and 3Shape Inc.’s Opening Claim Construction Brief, Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, June 19, 2019
1021	Respondent 3Shape A/S, 3Shape Trios A/S, and 3Shape Inc.’s Rebuttal Claim Construction Brief, Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, June 28, 2019
1022	Complainant Align Technology Inc.’s Opening Claim Construction Brief, Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, June 19, 2019
1023	Complainant Align Technology Inc.’s Reply Claim Construction Brief, Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, June28, 2019

EXHIBIT	DESCRIPTION
1024	Stipulation and [Proposed] Order for Stay in *Align Technology, Inc. v. 3Shape A/S*, Civil Action No. 1:17-cv-01950-LPS-CJB (D. Del.), March 8, 2019
1025	PACER Docket Sheet, *Align v. 3Shape*, Civ. Action No. 1:18-cv-01950 (downloaded on November 25, 2019)
1026	Complainant Align Technology Inc.'s Pre-Hearing Brief [public version], Inv. No. 337-TA-1144, *In the Matter of Certain Dental and Orthodontic Scanners and Software*, dated August 30, 2019
1027	International Publication No. WO 00/19929, published on April 13, 2000 to M. Chishti *et al*. ("Chishti")
1028	The American Heritage College Dictionary, 3rd Ed., 1997, Houghton Mifflin Company, p. 982, definition of "palate"
1029	The American Heritage College Dictionary, 3rd Ed., 1997, Houghton Mifflin Company, p. 1192, definition of "ruga"
1030	The American Heritage College Dictionary, 3rd Ed., 1997, Houghton Mifflin Company, p. 372, definition of "dentition"
1031	International Publication No. WO 01/80761, published on November 1, 2001 to R. Rubbert *et al.*

APPENDIX B - ADDITIONAL REAL PARTIES-IN-INTEREST

Allan Junge Hyldal	Lene Nørgaard
Anders Gaarde	Lise Thorning Christensen
Anders Kjær-Nielsen	Mads Brøkner Christiansen
Anja Engblad	Martin Baltzer
Birk Plönnings	Michael Bing
Bruce Frederic Mendel	Michael Pedersen
Casper Rasmussen	Michael Vinther
Christian Lysholdt Dünweber	Miguel Dovalo
Christian Pejrup	Mikael Toxværd Petersen
Christophe Barthe	Mike van der Poel
David Fischer	Mikkel Ninn-Grønne
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Esben Rosenlund Hansen	Morten Ryde Holm-Hansen
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Karl Josef Hollenbeck	Rune Fisker
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Kasper Kabell Kristensen	Sophie Ellersgaard
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Klaus Rudbæk Høj	Stefan Elmsted Jensen
Kristian Evers Hansen	Søren Greve Jensen
Kristian Worziger Nielsen	Søren Maagaard Olsen
Kristine Slot	Thomas Clemen Pedersen
Krzysztof Christopher Adamus	Thomas Geoffrey Moon
Lars Christian Lund	Thomas Højgaard Allin
Lars Henrik Jakobsen	Tim Trækjær
Lars Henriksen	Tommy Sanddal Poulsen
Lei Zhang	Ye Jin
	Zhengjie Li

CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that the word count for the foregoing Petition totals 13,458 words in the body of the petition and 515 words in the figures, excluding the parts which are exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF FILING AND SERVICE

The undersigned hereby certifies that on this 9th day of December, 2019 a true and correct copy of the foregoing **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 7,156,661 B2 UNDER 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq*.** and **EXHIBITS 1001-1031** are being filed via PTAB E2E and served by overnight UPS on the correspondence address of record for **U.S. Patent No. 7,156,661** as follows:

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