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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.

DENTAL IMAGING TECHNOLOGIES CORPORATION
Patent Owner

Case No. IPR2024-00548
Patent 10,076,391

**PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO.
10,076,391 B2 UNDER 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.***

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	1
II. MANDATORY NOTICES PURSUANT TO 37 C.F.R. §42.8(a)(1)	1
A. Real Parties-In-Interest.....	1
B. Identification of Related Matters Under 37 C.F.R. §42.8(b)(2)	2
C. Lead and Backup Counsel.....	2
D. Service Information Under 37 C.F.R. §42.8(b)(4).....	3
III. PAYMENT OF FEES	3
IV. REQUIREMENTS UNDER 37 C.F.R. §42.104.....	3
A. Grounds for Standing	3
B. Identification of Challenges and Precise Relief Requested	4
C. Prior Art Qualification of Asserted References	5
V. BACKGROUND	6
A. The Purported Invention.....	6
B. The '391 Patent Examination History	6
C. Summary of the Applied Prior Art.....	6
1. “Sommer”	6
2. “Malfliet”	8
3. “Estépar”	8
4. “Rubbert”	9
D. Person of Ordinary Skill in the Art (“POSITA”).....	9
VI. CLAIM CONSTRUCTION	9

VII. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING	12
A. Claims 1, 5-12 and 21 Would Have Been Obvious Over Sommer in View of Rubbert and Malfliet (Ground 1).....	12
1. Claim 1 (Preamble): A method of bite registration, comprising the steps of:	12
a. [1.1]: generating 3-d dimensional (3D) teeth models of the upper jaw and the lower jaw;.....	13
b. [1.2]: acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw;	14
c. [1.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;.....	16
d. [1.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;.....	17
e. [1.5]: repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;.....	19
f. [1.6]: selecting two or more successful bite registrations by evaluating the at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and.....	20

g.	[1.7]: computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and wherein in step e, when repeating to perform step b, the location of the acquired bite surface is changed.....	21
2.	Claim 5 (Preamble): The method of bite registration according to claim 1, wherein step a includes the steps of:.....	23
a.	[5.1]: capturing 3D teeth surface on the upper jaw or lower jaw by a scanner;	23
b.	[5.2]: judging whether the captured 3D teeth surface is the first one or not during the scan;.....	24
c.	[5.3]: if the captured portion is the first one, accepting the captured 3D teeth surface, and if further succeeding to accept, combining the captured 3D teeth surface with the 3D teeth model; and.....	25
d.	[5.4]: if the captured portion is not the first one, attempting to stitch the captured 3D teeth surface onto the existing 3D teeth model; if succeeding to stitch, combining the captured 3D teeth surface with the existing 3D teeth model.....	26
3.	Claim 6: The method of bite registration according to claim 1, wherein step d including step of: if the alignment is not successful, the bite surface is discarded and the user receives a notification of failing to align or to register the bite surface, wherein if the alignment is not successful, automatically returning back to step b until the alignment is successful.....	27
4.	Claim 7: The method of bite registration according to claim 1, wherein the alignment is completed at least by stitching of a portion of 3D teeth surface of the bite surface with the 3D teeth models of the upper jaw and the lower jaw, where the bite surface includes a tooth of the upper jaw and an opposing tooth of the lower jaw.....	28

5. Claim 8 (Preamble): The method of bite registration according to claim 1, wherein the alignment can be completed at least by stitching of a portion of 3D teeth surface of the acquired bite surface with either the lower or the upper arch, wherein the stitching process includes the steps of: 29
 - a. [8.1]: generating candidate 3D rigid transformations to place the 3D teeth surface relative to the 3D teeth model; 30
 - b. [8.2] evaluating a metric of the candidate 3D rigid transformations using the relative placement of the 3D teeth surface relative to the 3D teeth model; 31
 - c. [8.3] choosing the best 3D rigid transformation which corresponds to a best metric; and if the best metric goes below a predetermined threshold, accepting the corresponding 3D rigid transformation; if the best metric exceeds a predetermined threshold, rejecting the stitching. 32
6. Claim 9: The method of bite registration according to claim 1, wherein the teeth contained in the bite surface are selected from incisors, premolar or molars.....33
7. Claim 10: The method of bite registration according to claim 1, wherein the bite surface is acquired based on one or more bite views captured by a scanner.....34
8. Claim 11: The method of bite registration according to claim 1, wherein the alignment is completed in a manual way, a semi-automatic way or automatic way.....34
9. Claim 12: The method of bite registration according to claim 1, wherein the final bite registration is used to construct a global 3D teeth model. 35
10. Claim 21 (Preamble): A method of bite registration, comprising:.....36

a.	[21.1]: a. generating 3-dimensional (3D) teeth models of the upper jaw and the lower jaw;.....	36
b.	[21.2]: b. acquiring a bite surface containing a portion of the upper jaw and an opposing portion of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw;.....	36
c.	[21.3]: c. attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface to achieve successful alignment;.....	36
d.	[21.4]: d. displaying the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface where successful alignment is achieved;	37
e.	[21.5]: e. repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;.....	37
f.	[21.6]: selecting two or more successful bite registrations by evaluating the at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and.....	37
g.	[21.7]: computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and wherein step e, when repeating to perform step b, the location of the acquired bite surface is changed.	37
11.	Claims 1, 5-12, and 21 Would Have Been Obvious.....	37
a.	Difference between the claimed invention and the prior art.	38
b.	A POSITA would have had motivation to combine the disclosures of Sommer, Rubbert, and Malfliet.	38

c.	A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Rubbert, Malfliet, and knowledge generally available in the art.....	44
B.	Claims 2-4 Would Have Been Obvious Over Sommer in View of Rubbert, Malfliet, and Estépar (Ground 2).....	46
1.	Claim 2: The method of bite registration according to claim 1, wherein the computation of the final bite registration involves the optimization of a cost function depending on the selected successful bite registrations.....	46
2.	Claim 3: The method of bite registration according to claim 1, wherein the computation of the final bite registration involves one or more matrix interpolations of the selected successful bite registrations.	48
3.	Claim 4: The method of bite registration according to claim 3, wherein said one or more interpolations contain steps of: decomposing each matrix into an equivalent set of values; interpolating corresponding values from each set of values; and recomposing a matrix from the interpolated set of values.	50
4.	Claims 2-4 Would Have Been Obvious.....	52
a.	Difference between the claimed invention and the prior art.	52
b.	A POSITA would have had motivation to combine the disclosures of Sommer, Rubbert, Malfliet, and Estépar.	52
c.	A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Rubbert, Malfliet, and Estépar and knowledge generally available in the art.....	52
C.	Claims 13, 14, and 17-19 Would Have Been Obvious Over Sommer in View of Malfliet (Ground 3).	53

1.	Claim 13 (Preamble): A system for bite registration, comprising:.....	53
a.	[13.1]: means for generating 3D teeth models of the upper jaw and the lower jaw;.....	54
b.	[13.2]: means for acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously;	54
c.	[13.3]: means for attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;.....	54
d.	[13.4] means for displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;	54
e.	[13.5] means for obtaining at least two successful bite registrations corresponding to different displayed bite surface by repeating;	55
f.	[13.6] means for selecting two or more successful bite registrations by evaluating at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and.....	55
g.	[13.7] means for computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and	56
h.	[13.8] wherein in step e, when repeating to perform step b, the location of the acquired bite surface is changed.....	56

2. Claim 14: The system for bite registration according to claim 13, wherein the computation of the final bite registration involves the optimization of a cost function depending on the selected successful bite registrations.....56
3. Claim 17: The system for bite registration according to claim 13, wherein means for attempting to align the 3D teeth models includes: module for, if the alignment is not successful, discarding the bite surface and sending a notification of failing to align to the user. 56
4. Claim 18 (Preamble): A system for bite registration, including a scanner and a computerized workstation, wherein the workstation is configured as: 57
 - a. [18.1]: obtaining 3D teeth models of the upper jaw and the lower jaw, generated respectively, by the scanner; 57
 - b. [18.2]: acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw; 57
 - c. [18.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface at the workstation; 58
 - d. [18.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful; 58
 - e. [18.5]: repeating steps acquiring to step of displaying so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces; 58
 - f. [18.6]: selecting two or more successful bite registrations by evaluating at least two successful bite registrations; and 58

g.	[18.7]: computing a final bite registration using the selected two or more successful bite registrations, and where in the repeating step, when repeating to perform the acquiring step, the location of the acquired bite surface is changed.....	59
5.	Claim 19: The system for bite registration according to claim 18, wherein the system is used to construct a global 3D teeth model.	59
6.	Claims 13, 14, and 17-19 Would Have Been Obvious.....	59
a.	Difference between the claimed invention and the prior art.	59
b.	A POSITA would have had motivation to combine the disclosures of Sommer and Malfliet.....	60
c.	A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Malfliet, and knowledge generally available in the art.....	61
D.	Claims 15, 16, and 20 Would Have Been Obvious Over Sommer in View of Malfliet and Estépar (Ground 4).	62
1.	Claim 15: The system for bite registration according to claim 13, wherein means for computing the final bite registration involves device for one or more matrix interpolations of the selected successful bite registrations.....	62
2.	Claim 16: The system for bite registration according to claim 15, wherein device for one or more matrix interpolations includes: module for decomposing each matrix into an equivalent set of values; module for interpolating corresponding values from each set of values; and module for recomposing a matrix from the interpolated set of values.	62
3.	Claim 20 (Preamble): A method of bite registration, characterized by comprising the steps of:.....	62

a.	[20.1]: generating 3-dimensional (3D) teeth models of the upper jaw and the lower jaw;.....	63
b.	[20.2]: acquiring a bite surface containing a part of at least one tooth of the upper jaw and a part of at least one opposing tooth of the lower jaw simultaneously;	63
c.	[20.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;.....	63
d.	[20.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;.....	63
e.	[20.5]: repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;.....	63
f.	[20.6]: selecting one or more successful bite registrations by evaluating at least two successful bite registrations; and.....	63
g.	[20.7]: computing a final bite registration using selected one or more successful bite registrations, wherein the computation of the final bite registration involves one or more matrix interpolations of the selected successful bite registrations.....	64
4.	Claims 15, 16, and 20 Would Have Been Obvious	64
a.	Difference between the claimed invention and the prior art.	64
b.	A POSITA would have had motivation to combine the disclosures of Sommer, Malfliet, and Estépar.....	65

Petition for *Inter Partes* Review of U.S. Patent No. 10,076,391

- c. A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Malfliet, and Estépar and knowledge generally available in the art.....65

VIII. OTHER CONSIDERATIONS 66

- A. Any Purported Secondary Considerations Evidence Does Not Overcome the Strong Evidence of the Obviousness of the Claims.....66

- B. The Board Should Not Deny This Petition Under §314(a).....66

- C. The Board Should Not Deny This Petition Under §325(d) 67

IX. CONCLUSION.....67

APPENDIX A—LIST OF EXHIBITS

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

CERTIFICATE OF SERVICE

TABLE OF AUTHORITIES

Cases	Page(s)
<i>3Shape A/S v. Carestream Dental, LLC</i> , Civ. Action No. 22-cv-01829 (N.D. Ga.)	2
<i>Graham v. John Deere Co.</i> , 383 U.S. 1 (1966).....	12
<i>Intel Corp. v. Qualcomm Inc.</i> , 21 F.4th 801 (Fed. Cir. 2021)	11
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007).....	<i>passim</i>
<i>Sony Interactive Entertainment LLC v. Bot M8, LLC</i> , IPR2020-00963, Paper 9 (PTAB Nov. 20, 2020).....	11
<i>Sotera Wireless, Inc. v. Masimo Corp.</i> , IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020)	66, 67
<i>Target Corp. v. Proxicom Wireless, Inc.</i> , IPR2020-00979, Paper 11 (PTAB Dec. 4, 2020)	11
<i>Toyota Motor Corp. v. Cellport Systems, Inc.</i> , IPR2015-00633, Paper 11 (PTAB Aug. 14, 2015).....	9
<i>Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.</i> , 200 F.3d 795 (Fed. Cir. 1999)	10

Statutes

35 U.S.C. §102(a)(1).....	5, 6
35 U.S.C. §103.....	5, 12
35 U.S.C. §112, ¶6.....	10
35 U.S.C. §§311–19.....	1
35 U.S.C. §312(a)(2).....	1
35 U.S.C. §314(a)	66, 67
35 U.S.C. §318(a)	4
35 U.S.C. §325(d)	67

Rules

37 C.F.R. §42.8(a)(1).....	1
37 C.F.R. §42.8(b)(1).....	1
37 C.F.R. §42.8(b)(2).....	2
37 C.F.R. §42.8(b)(3).....	2
37 C.F.R. §42.8(b)(4).....	3
37 C.F.R. § 42.10(a).....	2
37 C.F.R. §42.10(b)	3
37 C.F.R. §42.15(a).....	3
37 C.F.R. §42.100 <i>et seq.</i>	1
37 C.F.R. §42.102(a)(2).....	3
37 C.F.R. §42.104	3
37 C.F.R. §42.104(a).....	3
37 C.F.R. §42.104(b)	4

I. INTRODUCTION

3SHAPE A/S and 3SHAPE INC. (“Petitioners”) respectfully request *inter partes* review for Claims 1-21 of U.S. Patent No. 10,076,391 (“the ’391 Patent”) (EX1001) in accordance with 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.*

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

A. Real Parties-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 Germany GmbH, 3Shape France SAS, 3Shape Italy SRL, 3SHAPE UK LIMITED, 3SHAPE DOOEL Skopje, 3Shape S.A.S., 3Shape (Shanghai) Co., Ltd., 3Shape Do Brasil Soluções Tecnológicas Para Saude Ltda, 3Shape Australia Pty Ltd., 3Shape Trios Sociedad Limitada, 3Shape Japan GK, 3Shape Ukraine Ltd., SC Investment Company, LLC, SoundBite Technology, LLC, Shenzhen Full Contour Design Company Ltd., 3Shape Design Services Costa Rica, S.R.L., 3Shape Design Services, LLC, 3Shape Medical Equipment Manufacture (Shanghai) Ltd., 3Shape Korea Ltd., 3Shape Manufacturing US LLC, EQT IX JAWS BIDCO S.A.R.L., Clausen Engineering APS, Tais Clausen, DM Family Office ApS, Deichmann Media APS, and Nikolaj Hoffmann Deichmann 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:

Related District Court Proceeding

3Shape A/S v. Carestream Dental, LLC, Civ. Action No. 22-cv-01829 (N.D. Ga.) (“Related Litigation”).

Related Applications

The ’391 Patent issued from U.S. Patent Application No. 14/770,177, which is a National Stage of PCT International Application No. PCT/CN2013/72420, filed on March 11, 2013, which published as PCT International Publication No. WO 2014/139078 on September 18, 2014.

C. Lead and Backup Counsel

Pursuant to 37 C.F.R. §§42.8(b)(3) and 42.10(a), Petitioners hereby identify its 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 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 '391 Patent is available for *inter partes* review in accordance with 37 C.F.R.

§42.102(a)(2). Petitioners are not barred or estopped from requesting *inter partes* review challenging the claims of the '391 Patent on the grounds identified herein.

This Petition is filed within one year from the date on which Petitioners were served counterclaims by Patent Owner in the Related Litigation, which asserted infringement of the '391 Patent. EX1004.

Neither Petitioners nor its privies have received a final written decision under 35 U.S.C. §318(a) regarding any claim of the '391 Patent on any ground that was raised or could have been raised by Petitioners or its privies in any *inter partes* review, post grant review, or covered business method patent review.

B. Identification of Challenges and Precise Relief Requested

Pursuant to 37 C.F.R. §42.104(b), Petitioners challenge Claims 1-21 of the '391 Patent, and request that these claims be found unpatentable over the prior art for the reasons given below. Petitioners' Grounds for challenging the validity of Claims 1-21 are as follows:

Ground	References	Basis	Claims Challenged
1	Sommer (EX1005) in view of Rubbert (EX1008) and Malfliet (EX1006)	35 U.S.C. §103	1, 5-12, 21
2	Sommer in view of Rubbert, Malfliet, and Estépar (EX1007)	35 U.S.C. §103	2-4
3	Sommer in view of Malfliet	35 U.S.C. §103	13, 14, 17-19

Ground	References	Basis	Claims Challenged
4	Sommer in view of Malfliet, and Estépar	35 U.S.C. §103	15, 16, 20

In addition to the above prior art, Petitioners rely upon evidence listed in the Exhibit List, including the Declaration and *Curriculum Vitae* of Eli Saber, Ph.D. (EXs1009-1010) and the Declaration and *Curriculum Vitae* of Sylvia Hall-Ellis, Ph.D. (EXs1011-1012).

C. Prior Art Qualification of Asserted References

The '391 Patent was filed on August 25, 2018 as U.S. Patent Application No. 14/770,177 (“the '177 Application”). EX1001. The '177 Application is a National Stage of PCT International Application No. PCT/CN13/72420, filed on March 11, 2013 (“the '420 PCT Application”). The '420 PCT Application was published on September 18, 2014 as PCT International Publication No. WO 2014/139078 (“the '078 PCT”) (EX1003).

Even if the '391 Patent is deemed entitled to its earliest priority date, all of the applied references in this Petition are prior art.

Sommer (EX1005), published no later than August 24, 2010, constitutes prior art at least under 35 U.S.C. §102(a)(1).

Malfliet (EX1006), published no later than June 10, 2010, constitutes prior art at least under 35 U.S.C. §102(a)(1).

Estépar (EX1007), published no later than September 26-29, 2004, constitutes prior art at least under 35 U.S.C. §102(a)(1).

Rubbert (EX1008), published no later than November 1, 2001, constitutes prior art at least under 35 U.S.C. §102(a)(1).

V. BACKGROUND

A. The Purported Invention

The '391 Patent relates to a method and system for bite registration. EX1001, Abstract. In this method and system, when the 3D teeth model of both the upper and lower jaws are successfully aligned with the bite surface, the bite surface with the 3D teeth models is displayed for further evaluation. *Id.* The bite surfaces selected by the user are combined to generate a final bite registration. *Id.*; EX1009, ¶34.

B. The '391 Patent Examination History

The '391 Patent issued on September 18, 2018 from U.S. Application 14/770,177, filed on August 25, 2015, which is a National Stage of PCT/CN13/72420, filed on March 11, 2013. The '420 PCT Application published on September 18, 2014 as WO2014/139078 ("the '078 PCT") (EX1003).

C. Summary of the Applied Prior Art

1. "Sommer"

Sommer describes methods and systems for correlating the teeth of the upper and lower jaws for the design of a dental restoration or an orthodontic treatment plan. EX1005, 1. Sommer provides a process wherein manual pre-correlation is

performed by the user with the final calculation of the correlation done by software.

Id. By rotating the models, the user can see the matching parts between the bite surface (*e.g.*, “buccal model”) and the upper and lower jaw models. *Id.*, 2; EX1009, ¶35.

When the bite surface is correlated to the jaws successfully, the user will observe a “leopard” pattern. EX1005, 2. If the correlation is not successful, the bite surface model shakes for a moment and stays between the upper and lower jaw models requiring the user to redo the pre-correlation step and try to find a better matching area. *Id.* One method disclosed by Sommer for redoing this procedure is to add an additional bite surface scan to enlarge the bite surface model. *Id.*, 3; EX1009, ¶36.

Sommer also suggests improving the precision of the correlation between the upper and lower jaws by using more than one bite surface (*e.g.*, one bite surface from each quadrant). EX1005, 4; EX1009, ¶37.

While Sommer suggests that its methods and systems are to be used with the CEREC dental product, Sommer states that obtaining digital impressions of the upper and lower jaws the dental scanning systems is typically done separately. EX1005, 1. Further, Sommer acknowledges that such methods for obtaining digital impressions are well-known and technically solved in the art. *Id.*; EX1009, ¶38.

2. “Malfliet”

Malfliet discloses a method for automatic or semi-automatic planning of dental treatment. EX1006, Abstract. Not only does Malfliet disclose a scanner and a workstation (*id.*, FIG. 1), Malfliet discusses converting the scanned data into a digital model (*id.*, ¶[0035]). Malfliet also discloses methods by which 3D models can be registered onto each other by manually translating and/or rotating one of the 3D models with respect to the other (*id.*, ¶[0036]) as well as by automatic registration algorithms based on feature recognition (*id.*, ¶[0038]). In particular, Malfliet discloses a final mapping of a 3D representation that is performed using an Iterative Closest Point (ICP) registration algorithm which finds the optimal transformation necessary to align sets of data points of scans. *Id.*, ¶[0044]; EX1009, ¶39.

3. “Estépar”

Estépar is referenced in Paragraph [0038] of Malfliet and details the process of ICP registration. For example, Estépar describes how model shapes are first decomposed from matrix form to point set form. EX1007, 235. Then, ICP finds the rigid body that aligns the model shapes by minimizing the distance between surface points of one model that correspond with the surface points of a second model. *Id.* Once a minimum error threshold is achieved, the model shapes are recomposed for 3D representation purposes. *Id.*; EX1009, ¶¶40-41.

4. “Rubbert”

Rubbert discloses both hardware and software for interactive, computer based orthodontist planning, dental appliance design, and appliance manufacturing that relies on virtual tooth models. EX1008, Abstract; EX1009, ¶42.

Not only does Rubbert disclose obtaining dentition scans (EX1008, 85:16-21), Rubbert also discloses methods for determining an entry point for registering such scans into a virtual tooth model (*id.*, 57-58), frame to frame registration of such scans (*id.*, 58-62) and cumulative registration of the entire jaw (*id.*, 63-69). Relevant portions of these methods are described in greater detail below. EX1009, ¶43.

D. Person of Ordinary Skill in the Art (“POSITA”)

A POSITA is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. Regarding the ’391 Patent, a POSITA would have at least (1) a bachelor’s degree in electrical engineering, computer engineering, or computer science (or equivalent course work) and two to three years of work experience in 3D imaging and modeling of physical structures, or (2) a master’s degree in electrical engineering, computer engineering, or computer science (or equivalent course work) with a focus in 3D imaging and modeling of physical structures. EX1009, ¶¶32-33.

VI. CLAIM CONSTRUCTION

The Board only construes the claims when necessary to resolve the underlying controversy. *Toyota Motor Corp. v. Cellport Systems, Inc.*, IPR2015-00633, Paper

11 at 16 (PTAB Aug. 14, 2015) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Petitioners believe that no express constructions of the claims are necessary. EX1009, ¶¶44-45.

Petitioners note that the constructions of some claim terms are disputed in the Related Litigation. Petitioner asserted that the terms “displaying ... if the alignment is successful” (Claims 1, 13, 18, 20-23), “successful bite registration” (Claims 1, 13, 18, 20-23), “selecting said two or more of the displayed successful bite registrations” (Claims 1, 13, 21), “selecting two or more successful bite registrations by evaluating [the] at least two successful bite registrations” (Claims 1, 13, 18, 21), “selecting one or more successful bite registrations by evaluating at least two successful bite registrations (Claims 20), “best metric” (Claim 8) and the entirety of Claims 13 and 18 are indefinite, while the Patent Owner asserted that these terms should be given their plain and ordinary meaning. EXs1014-1015. While the proper metes and bounds of these terms are disputed, the cited prior art falls within these bounds whatever they may be. Petitioners are not waiving their right to contest indefiniteness in the Related Litigation by virtue of this Petition.

Petitioner also asserted that Elements [13.4]-[13.6] are subject to 35 U.S.C. §112, ¶6 with the recited function but no corresponding structure in the specification, while the Patent Owner asserted that these terms have the recited function and specific structure can be found at 5:56-6:24 (Element [13.4]), 6:25-38 (Element

[13.5]), and 6:39-7:11 (Element [13.6]). EXs1014-1015. That is, (i) “means for displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful,” (ii) “means for obtaining at least two successful bite registrations corresponding to different displayed bite surface by repeating,” and (iii) “means for selecting two or more successful bite registrations by evaluating at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations” have the structure of a “computerized workstation and associated software.” EX1015, 27; EX1009, ¶46.

Petitioners believe that resolution of this Petition does not depend on which constructions are used because these features of the claims are disclosed by the prior art regardless of the construction. Petitioners contend that these terms should be interpreted consistent with the *Philips* standard. In any event, the Board has consistently held that Petitioners may assert indefiniteness positions in parallel litigation, while simultaneously arguing that the prior art discloses the elements containing those terms. *See Target Corp. v. Proxicom Wireless, Inc.*, IPR2020-00979, Paper 11 at 16-17 (PTAB Dec. 4, 2020); *Sony Interactive Entertainment LLC v. Bot M8, LLC*, IPR2020-00963, Paper 9 at 11 (PTAB Nov. 20, 2020). *See also Intel Corp. v. Qualcomm Inc.*, 21 F.4th 801, 812-814 (Fed. Cir. 2021). The Challenged Claims are unpatentable under all the potential constructions.

VII. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING

Obviousness under 35 U.S.C. §103 is determined by evaluating several factual inquiries, namely the scope and content of the prior art, ascertaining the differences between the claimed invention and the prior art, and resolving the level of ordinary skill in the relevant art, as well as considering any objective evidence of “secondary considerations” relevant to obviousness. *Graham v. John Deere Co.*, 383 U.S. 1 (1966). Further, the purported invention of the ‘391 Patent is nothing more than the combination of well-known technologies and techniques yielding a predictable outcome. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007).

The following explains why Claims 1-21 of the ’391 Patent are unpatentable over the prior art asserted in Grounds 1-4. EX1009, ¶¶30-31, 344.

A. Claims 1, 5-12 and 21 Would Have Been Obvious Over Sommer in View of Rubbert and Malfliet (Ground 1).

The following sections explain where each element of Claims 1, 5-12, and 21 is found in the prior art. EX1009, ¶¶47-48.

1. Claim 1 (Preamble): A method of bite registration, comprising the steps of:

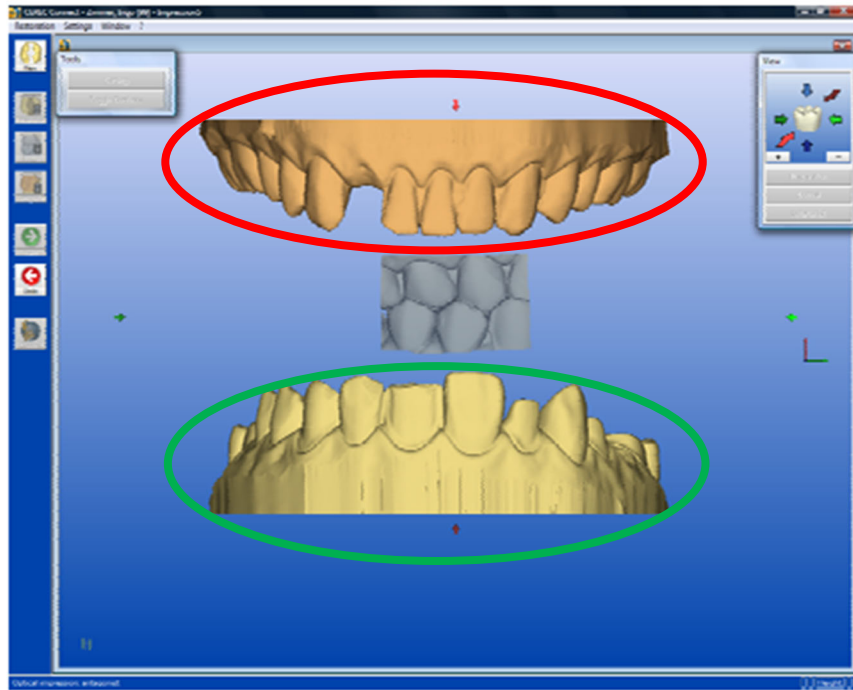
Sommer discloses methods and systems for correlating bite surfaces based on data obtained from 3D models of teeth from the upper and lower jaws. *See* §V.C.1. And, Rubbert discloses a scanner and a workstation that capture 3D teeth surfaces

of the upper and lower jaws and then processes those captured images to generate the 3D teeth models relied on by Sommer. *See* §V.C.4.; EX1009, ¶49.

Here, Sommer discloses the Preamble of Claim 1. Sommer describes its “correlation method of bite registration” as a “common technique [that] use[s] a triple-point-matching method.” EX1005, 1. This system and method are described by Sommer for use with the CEREC software produced by SIRONA. *Id.* Sommer further discloses that “[i]n order to correlate both jaws...information which provides the connection between the upper and lower jaw can be provided by...capturing optical impressions from the buccal view.” *Id.* Thus, by obtaining such a digital impression of a bite, and correlating both jaws for a patient, Sommer discloses a method of bite registration. EX1009, ¶¶50-55.

a. [1.1]: generating 3-d dimensional (3D) teeth models of the upper jaw and the lower jaw;

Sommer discloses Element [1.1]. Sommer describes the “user interaction step in its software where the “user drag&drops the 3D-model of the buccal over the corresponding area of the upper and the lower jaw.” EX1005, 1. According to Sommer, “[i]n the first step the 3D models of the preparation, the antagonist and the buccal are shown.” *Id.* Sommer provides an illustration, wherein the 3D teeth models of the upper jaw (circled in red) and the lower jaw (circled in green) are generated for user viewing:

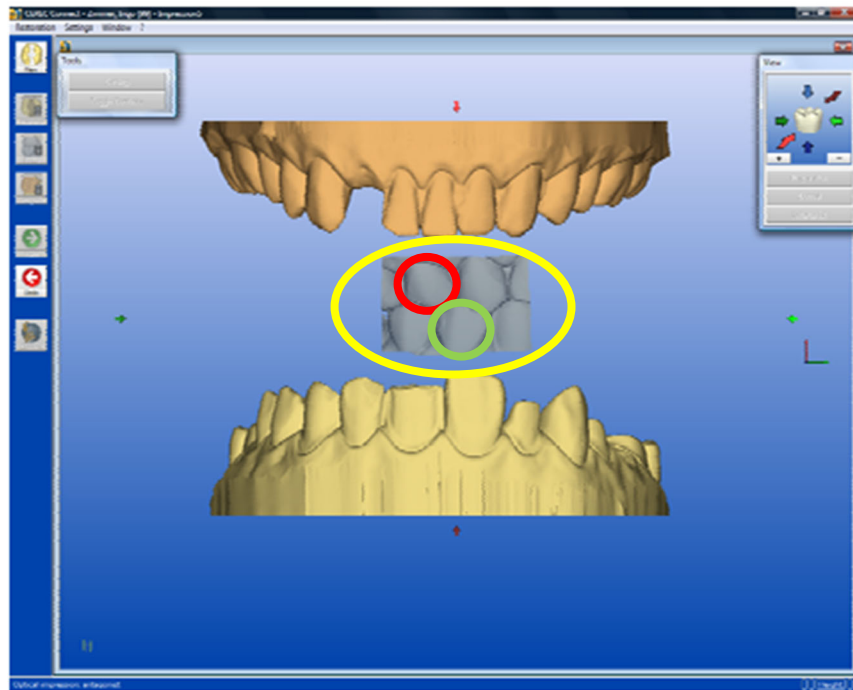


Id., 2. Sommer then discloses that the user can “[r]otate both models preparation and the antagonist.” *Id.* Thus, Sommer discloses Element [1.1]: generating 3-d dimensional (3D) teeth models of the upper jaw and the lower jaw. EX1009, ¶¶56-60.

- b. **[1.2]: acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw;**

Sommer in combination with Rubbert discloses Element [1.2]. Sommer discloses that “[i]n order to correlate both jaws...information which provides the connection between the upper and lower jaw can be provided by...capturing optical impressions from the buccal view.” EX1005, 1. Further, Sommer states that “[t]he method by taking the optical impressions from the bite is well known and technical

solved.” *Id.* Sommer then further describes generating a “buccal model [which] is placed in the middle between preparation and antagonist.” *Id.* The buccal model illustration displays acquiring a bite surface (circled yellow) containing a portion of at least one tooth of the upper jaw (circled in red) and a portion of at least one opposing tooth of the lower jaw (circled in green) simultaneously in a clenched state:



Id., 2. Thus, Sommer discloses Element [1.2]. EX1009, ¶¶61-65.

Patent Owner may argue that these disclosures in Sommer do not explicitly teach Element [1.2]. Patent Owner is incorrect. As shown in the illustration, the teeth are in a clenched state. Even if Sommer had not disclosed the element, Rubbert explicitly discloses the element. In particular, Rubbert discloses a scanner that is able to acquire bite surface images of the upper and lower jaw. EX1008, Abstract, 18:8-10, 56:5-7, FIG. 36. Rubbert also discloses acquiring a bite surface wherein

the upper jaw and the lower jaw are in a clenched state where the upper jaw is static relative to the lower jaw:

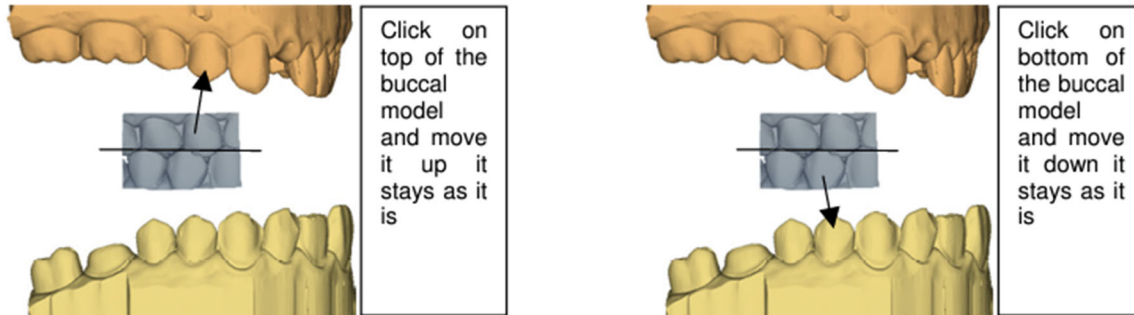
A bite registration scan is obtained from the patient to spatially correlate the scans of the upper and lower jaws *when the dentition is clenched*....This bite registration scan is usually needed at the beginning of treatment to set the relation between the upper and lower jaws. [Emphasis added.]

Id., 85:17-21. Thus, Sommer in combination with Rubbert also discloses Element [1.2]. EX1009, ¶¶66-67.

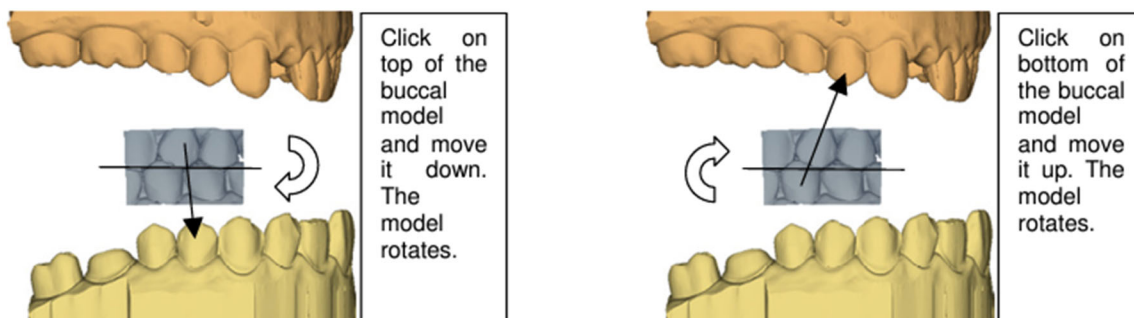
c. [1.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;

Sommer discloses Element [1.3]. Sommer states that “[t]he buccal model will be correlated to the preparation model automatically.” EX1005, 2. If the automatic “correlation was successful the buccal [sic] model matches the regarding position and you see the ‘leopard’ pattern.” *Id.* However, “[i]f the correlation was not successful, the buccal model shakes for a moment and stays in the middle between the models.” *Id.* Sommer then counsels the user to “redo this procedure [of rotating both models preparation and antagonist in the way that you can see the matching parts between the buccal model and the preparation/antagonist model] and try to find a better matching area when doing the ‘Drag&Drop’ or add an additional buccal shot to enlarge the buccal model.” *Id.* Sommer provides graphics that show steps of

rotating both models in the way that you can see the matching parts between the buccal model and the preparation/antagonist model:



In case that the buccal shot was taken in a different quadrant it will be visualized as if it was upside down. The software recognizes how you drag&drop the buccal model and rotates it automatically:

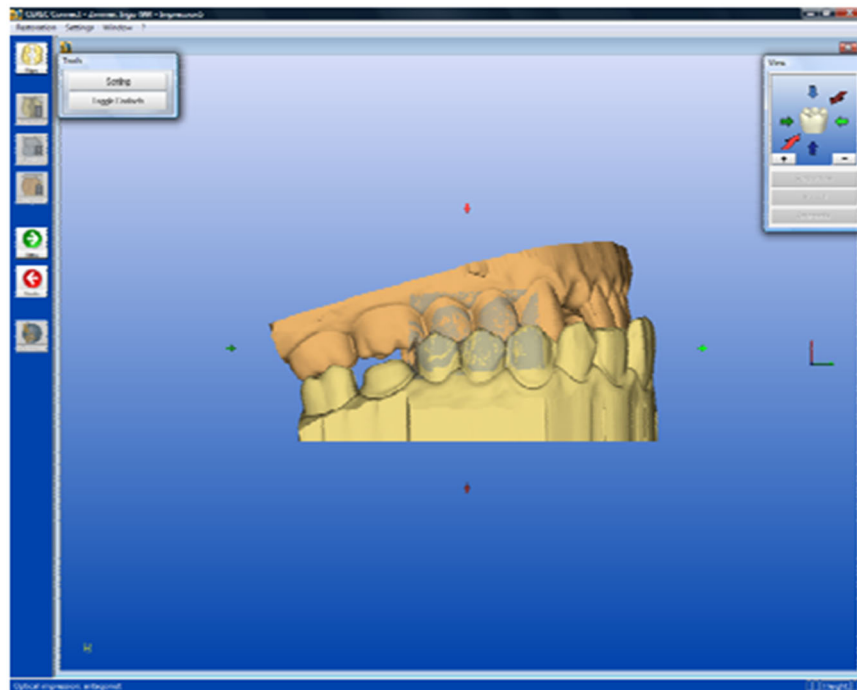


Id., 4. Accordingly, Sommer discloses first an automatic alignment of the 3D teeth models of the upper jaw and the lower jaw with the bite surface [buccal model]. If that is not successful, Sommer counsels the user to then attempt to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface [buccal model] by finding a better bite surface. Thus, Sommer discloses Element [1.3]. EX1009, ¶¶68-76.

- d. **[1.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw**

aligned with the bite surface if alignment is successful;

Sommer discloses Element [1.4]. As discussed above, Sommer discloses that “[t]he buccal model will be correlated to the preparation model automatically.” EX1005, 2. And, “[i]f the correlation was successful, the buccal [sic] model matches and you see the ‘leopard’ pattern.” *Id.* That is, Sommer discloses that the user should expect to see a “leopard” pattern displayed with the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if the alignment is successful. Sommer illustrates this “leopard pattern” displayed with the bite surface (grey) together with the 3D teeth models of the upper jaw (orange) and the lower jaw (yellow) aligned with the bite surface (grey) when the alignment is successful:



Id., 3. Thus, Sommer discloses Element [1.4]. EX1009, ¶¶77-81.

- e. **[1.5]: repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;**

Patent Owner conceded during prosecution that the Preamble of Claim 1 and Elements [1.1]-[1.4] were already found in the prior art. EX1002, 96-97. Sommer also discloses Element [1.5]. EX1009, ¶82.

For example, Sommer states that “the precision of the correlation between upper and lower jaw especially when doing full arches can be possibly improved by using more than one buccal image (e.g. one buccal image in each quadrant).” EX1005, 4. That is, Sommer teaches repeating step b (acquiring a bite surface [buccal image] containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw) for each of the quadrants. Sommer also teaches repeating step c (attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface). For example, Sommer notes that

Depending on the quadrant where you have taken the buccal image it can happen that the buccal model seems to be rotated upside down. In this case simply click on the top spot of the buccal model and move it to the model that is underneath. The buccal model automatically rotates and you can use the above described ‘Drag&Drop’ technique.

Id., 3. Thus, the automatic rotation of the buccal model and Drag&Drop technique (rotating both models preparation and antagonist in the way that you can see the matching parts between the buccal model and the preparation/antagonist model) constitute aligning the 3D teeth models of the upper jaw and the lower jaw with the additional bite surface [buccal model]—step c of Claim 1. EX1009, ¶¶83-86.

Finally, Sommer discloses repeating step d (displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful). As discussed above, Sommer states that “[i]f the correlation [of the buccal model connected with the preparation model and the antagonist model] was successful the buccal [sic] model matches and you see the ‘leopard’ pattern.” EX1005, 2. Thus, Sommer discloses for each bite surface (*i.e.*, buccal image) of a different quadrant, the user should expect to see a “leopard” pattern displayed with the bite surface aligned together with the 3D teeth models of the upper jaw and the lower jaw if the alignment is successful. As such, Sommer discloses all of the steps of Element [1.5]. EX1009, ¶¶87-90.

f. [1.6]: selecting two or more successful bite registrations by evaluating the at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and

Sommer also discloses Element [1.6]. Sommer states that for prior art products: “[a]s far as known all products in this field using the buccal method use an automatic correlation algorithm [and in] case that the software cannot correlate

the buccal images with either the upper jaw or lower jaw [*i.e.*, produce a successful bite registration], the user has to take additional images or remove not useful images until the software can calculate the correlation.” EX1005, 1. Sommer also suggests doing the same with its software: “In this case redo this procedure and try to find a better matching area when doing the ‘Drag&Drop’ or add an additional buccal shot to enlarge the buccal model.” *Id.*, 2. In addition to enlarging the buccal model to obtain a successful bite registration, Sommer suggests “improv[ing] the precision of the correlation between upper and lower jaw especially when doing full arches...by using more than one buccal image [two or more successful bite registrations] (e.g., one buccal image in each quadrant).” *Id.*, 4; EX1009, ¶¶91-94.

As discussed above, Sommer discloses a process for obtaining and selecting at least two successful bite registrations corresponding to different displayed bite surfaces after evaluating each of the separate alignment/correlations between the upper and lower jaw and the buccal image. EX1009, ¶¶95-96.

- g. [1.7]: computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and wherein in step e, when repeating to perform step b, the location of the acquired bite surface is changed.**

While Sommer discloses changing the location of the acquired bite surface in step e (when repeating to perform step b) (EX1005, 4 (“using more than one buccal image [two or more successful bite registrations] (e.g., one buccal image in each

quadrant)”), and provides a “solution [of] manual pre-correlation by the user combined with the final calculation done by the Software” (*id.*, 1), Sommer is silent regarding how the final calculation of “computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations” is performed. EX1009, ¶¶97-98.

However, this computation step was well known in the art. For example, Malfliet also teaches the digitization of bite registrations for use in registering the digital 3D models of the patient’s jaws. EX1006, ¶[0045]. Like Sommer, Malfliet discusses registering 3D models by “manually translating and/or rotating one of the 3D models with respect to the other.” *Id.*, [0036]. In this manner, “models are displayed on display 10 of the workstation 20 and an operator manipulates the models.” *Id.* Malfliet lists a number of techniques for manually and automatically registering 3D models. *Id.*, ¶¶[0036]-[0038]. With regard to the missing step of Element [1.7] that is not taught by Sommer, Malfliet expressly teaches that “[a] final mapping is performed [] by: a least-squares algorithm/n-point registration/ICP (Iterative Closest Point) registration, which will find the optimal transformation necessary to align both sets of points;....” *Id.*, ¶[0044]. Thus, Sommer in combination with Malfliet discloses Element [1.7]. EX1009, ¶¶99-103.

2. Claim 5 (Preamble): The method of bite registration according to claim 1, wherein step a includes the steps of:

Sommer discloses the Preamble of Claim 5. *See* §VII.A.1. Step a of Claim 1 recites “generating 3-d dimensional (3D) teeth models of the upper jaw and the lower jaw.” Claim 5 further characterizes the steps of step a of Claim 1. EX1009, ¶¶104-107.

a. [5.1]: capturing 3D teeth surface on the upper jaw or lower jaw by a scanner;

Sommer correlates between upper and lower jaws of digital impressions. EX1005, Title. Sommer states that “[c]apturing digital impressions from the upper jaw and lower jaw with [a] dental scanning system is typically done separately” but such systems are “well known and technically solved.” *Id.*, 1. Rubbert not only discloses such a well-known and technically solved dental scanning system, Rubbert discloses all of Element [5.1]. EX1009, ¶109.

Rubbert discloses that “[a] scanner is described which acquires images of the dentition.” EX1008, Abstract, FIG.2, 28:14-20. Rubbert provides a “flow chart...illustrating the steps performed to generate a complete three-dimensional model of the dentition of a patient from a series of scans of the upper and lower jaws.” *Id.*, 18:9-10 and FIG. 36. Thus, Rubbert discloses using an optical scanner to capture 3D teeth surface on the upper jaw or lower jaw by a scanner. EX1009, ¶¶110-113.

b. [5.2]: judging whether the captured 3D teeth surface is the first one or not during the scan;

Because Rubbert discloses a dental scanning system that performs all of the steps required to generate a complete three-dimensional model of a patient's dentition from a series of scans of the upper and lower jaws (EX1008., 18:9-10, 55:5-7 and FIG. 36), Rubbert also discloses Element [5.2]. Rubbert explains that “[t]he steps include an initial step 190 of determining an entry point into a registration process....” *Id.*, 56:7-12; EX1009, ¶¶114-116.

Regarding that initial step 190, *i.e.*, determining an entry point into a registration process, Rubbert states that the process

require[s] a starting point for fitting one frame, frame *i* to another frame, *i* + 1. The starting point, in the illustrated embodiment, is rough calculation of the offset between overlapping points in the frames in X, Y and Z directions....The starting point is the initial assumption of spatial relationship between one frame and the previous frame (and one frame and a set of previous frames).

EX1008, 57:4-11. Here, Rubbert's “starting point” is the same as the claimed “first scan” of Element [5.2]. *See also id.*, 34:1-5 (“One of the frames, such as the first frame in the series, is a starting point for registration and no transformation matrix is obtained for that frame.”). Rubbert goes on to describe a “method of calculation” which “is used to find an initial entry point into a registration algorithm between

successive frames of data.” *Id.*, 57:12-16. That is, Rubbert describes a process for judging whether that “starting point”/scan of the captured 3D teeth surface is the first one or not during the scan to be able to find an entry point into the registration process of generating a complete three-dimensional model of the dentition of a patient from a series of scans of the upper and lower jaws. EX1009, ¶¶117-121.

- c. **[5.3]: if the captured portion is the first one, accepting the captured 3D teeth surface, and if further succeeding to accept, combining the captured 3D teeth surface with the 3D teeth model; and**

Because Rubbert discloses a dental scanning system that performs all of the steps required to generate a complete three-dimensional model of a patient’s dentition (EX1008, 18:9-10, 55:5-7 and FIG. 36), Rubbert also discloses Element [5.3]. Rubbert discloses a process for determining if the captured portion of the teeth surface is the first one or “starting point.” Once that “starting point” captured 3D teeth surface scan is determined to be the first and accepted, Rubbert discloses a process for adding the “starting point” frame and additional frames to the three-dimensional computer model of the dentition of the upper and lower jaws that had been scanned. EX1009, ¶¶122-124.

For example, Rubbert discloses

Frame to frame registration [as] a process for registering one frame with another frame, that is, finding a best-fit in terms of translation and rotation [to] make overlapping points in the frames agree with each other. If the frames

are generated in sequential order, frame to frame registration refers to registration of the second frame to the first frame, the third frame to the second frame, from the fourth frame to the third frame, etc....What they see is ***an accurate three-dimensional representation of the dentition*** on the monitor, for those portions of the dentition that have been scanned thus far. ***As additional frames are obtained, they are registered to the previous frame and added to the computer model.***

EX1008, 58:14-25 (emphasis added). Thus, Rubbert discloses a process for combining that captured 3D teeth surface with a 3D teeth model. EX1009, ¶¶125-127.

- d. **[5.4]: if the captured portion is not the first one, attempting to stitch the captured 3D teeth surface onto the existing 3D teeth model; if succeeding to stitch, combining the captured 3D teeth surface with the existing 3D teeth model.**

Because Rubbert discloses a dental scanning system that performs all of the steps required to generate a complete three-dimensional model of a patient's dentition (EX1008, 18:9-10, 55:5-7 and FIG. 36), Rubbert also discloses Element [5.4]. Rubbert discloses a process for stitching the captured 3D teeth surface onto the existing 3D teeth model if the "starting point" scan is not the first scan: "As additional frames are obtained, they are registered to the previous frame and added to the computer model." *Id.*, 58: 24-25. Here, Rubbert's description of "frame to

frame registration” and the “addition” to the computer model is the same as the claimed “stitching” of Element [5.4]. This is done by “finding a best-fit in terms of translation and rotation [to] make overlapping points in the frame agree with each other.” *Id.*, 58:16-17. That is, Rubbert first attempts to stitch the captured 3D teeth surface onto the existing 3D teeth model by ensuring alignment between overlapping points of the “additional frame” and previously registered frame. EX1009, ¶¶128-133.

3. **Claim 6: The method of bite registration according to claim 1, wherein step d including step of: if the alignment is not successful, the bite surface is discarded and the user receives a notification of failing to align or to register the bite surface, wherein if the alignment is not successful, automatically returning back to step b until the alignment is successful.**

Sommer discloses the additional limitations of Claim 6. Sommer discloses that “[i]n case that the software cannot correlate the buccal images [bite surfaces] with either the upper jaw or lower jaw, the user has to take ... *remove not useful images* until the software can calculate the correlation [emphasis added].” EX1005, 1. Thus, Sommer discloses the module for step d of discarding the bite surface if the alignment is not successful. EX1009, ¶¶134-136.

Sommer also discloses sending a notification of failing to align to the user. For example, Sommer states that “[i]f the correlation was not successful, the buccal model shakes for a moment and stays in the middle between the models.” EX1005,

2. When the buccal model shakes and stays in the middle between the upper and lower jaw models, the user is notified of an alignment/correlation failure. EX1009, ¶¶137-139.

Sommer also discloses that if the alignment is not successful, the user should automatically return back to step b until the alignment is successful. That is, the user should acquire a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw. As mentioned above, Sommer states that “[i]n case that the software cannot correlate the buccal images [bite surfaces] with either the upper jaw or lower jaw, the user has to *take additional images* ... until the software can calculate the correlation [emphasis added].” EX1005, 1; EX1009, ¶¶140-143.

4. **Claim 7: The method of bite registration according to claim 1, wherein the alignment is completed at least by stitching of a portion of 3D teeth surface of the bite surface with the 3D teeth models of the upper jaw and the lower jaw, where the bite surface includes a tooth of the upper jaw and an opposing tooth of the lower jaw.**

Rubbert discloses the additional limitations of Claim 7. *See* §VII.A.2. As discussed above, “stitching” of 3D models can be performed using the “frame to frame registration process” and “addition” to the model as taught by Rubbert. EX1008, 58: 24-25. Rubbert also discloses an alignment process prior to stitching the captured portion of the 3D teeth surface of the bite surface with the 3D teeth

models of the upper and lower jaw. *Id.* Rubbert also discloses that alignment can be completed by stitching a portion of 3D teeth surface of the bite surface with the 3D teeth models of the upper jaw and the lower jaw, where the bite surface includes a tooth of the upper jaw and an opposing tooth of the lower jaw. Not only does Rubbert disclose individual “tooth modeling,” Rubbert also directly contemplates the use and registration of the opposing tooth of the other jaw for treatment planning. *Id.*, 10:9-13, 22:30-31, 72:1-5, 78:12-22, 84:1-5, 97:7-10, 98:18-26; EX1009, ¶¶144-148.

Thus, Rubbert discloses an “alignment [that] is completed at least by stitching of a portion of 3D teeth surface of the bite surface with the 3D teeth models of the upper jaw and the lower jaw, where the bite surface includes a tooth of the upper jaw and an opposing tooth of the lower jaw.” EX1009, ¶¶149-150.

5. Claim 8 (Preamble): The method of bite registration according to claim 1, wherein the alignment can be completed at least by stitching of a portion of 3D teeth surface of the acquired bite surface with either the lower or the upper arch, wherein the stitching process includes the steps of:

Sommer in combination with Rubbert discloses the Preamble of Claim 8. *See* §§VII.A.2., VII.A.4; EX1009, ¶151.

a. [8.1]: generating candidate 3D rigid transformations to place the 3D teeth surface relative to the 3D teeth model;

Rubbert discloses Element [8.1]. As discussed above, Rubbert discloses frame to frame registrations, *i.e.*, local registration between successive scans. However, Rubbert also describes “cumulative registration [which] is registration of a frame to more than one other frame, such as where one frame is registered to all previously registered frames [which ensures] more accuracy in the resulting three-dimensional model.” EX1008, 64:17-24; EX1009, ¶¶153-155.

Rubbert describes “a few examples” of the “numerous types of cumulative registrations that can be performed” by way of illustration in Figures 47A, 4B, 48A-48C, and 49-52. EX1008, 64:17-67:25. Cumulative registration includes 3D rigid transformations to place the 3D teeth surface relative to the 3D teeth model that is being generated. For example, one cumulative registration process of Rubbert uses “triangle surfaces [] formed on the points of frame 3 and minimal distance vectors [] calculated for each of the points in frame 1 and frame 2 (after registration to frame 1), and the other steps of Figure 40 are performed.” *Id.*, 64:31-65:2; EX1009, ¶¶156-158.

In one embodiment, Rubbert describes using a “transformation matrix [T]” that is applied to the frames. EX1008, 63:6-19. The “transformation matrix” of Rubbert is the same as the claimed “rigid transformation” of Element [8.1]. Thus,

Rubbert discloses generating candidate 3D rigid transformations to place the 3D teeth surface relative to the 3D teeth model. EX1009, ¶¶159-162.

b. [8.2] evaluating a metric of the candidate 3D rigid transformations using the relative placement of the 3D teeth surface relative to the 3D teeth model;

Rubbert discloses Element [8.2]. For example, Rubbert evaluates whether the quality (*i.e.*, metric) of the proposed registration is sufficient after the transformation matrix [T] has been applied to a frame:

At step D, the transformation matrix $[T]_2$ is applied to frame 2.

At step E, a registration is performed of the points of frame 1 to the points of frame 2, after the transformation matrix $[T]_2$ has been applied to frame 2. Basically the steps 1-11 of Figure 40A-40B are performed.

At step F, a check is made as to whether the quality of the registration is less than a threshold.

EX1008, 65:10-15. Thus, Rubbert discloses “evaluating a metric of the candidate 3D rigid transformations using the relative placement of the 3D teeth surface relative to the 3D teeth model.” EX1009, ¶¶163-166.

- c. **[8.3] choosing the best 3D rigid transformation which corresponds to a best metric; and if the best metric goes below a predetermined threshold, accepting the corresponding 3D rigid transformation; if the best metric exceeds a predetermined threshold, rejecting the stitching.**

Rubbert discloses Element [8.3]. Rubbert discloses that

At step F, a check is made as to whether the quality of the registration is less than a threshold. *If not, the registration is performed again* (with the points of frame 2 updated by a new transformation matrix). *Steps 278 and 280 are performed over and over again until either quality threshold is met or a maximum number of iterations has occurred.*

If the index is met or the maximum number of iterations has been reached, *the process proceeds to step G (282)*. The new transformation matrix for frame 2, designated $[T]_2'$ is obtained and stored.

At step H, the new transformation matrix $[T]_2'$ is applied to the points of frame 2.

At step I, *the new transformed points of frame 2 are added to a “global container”*.

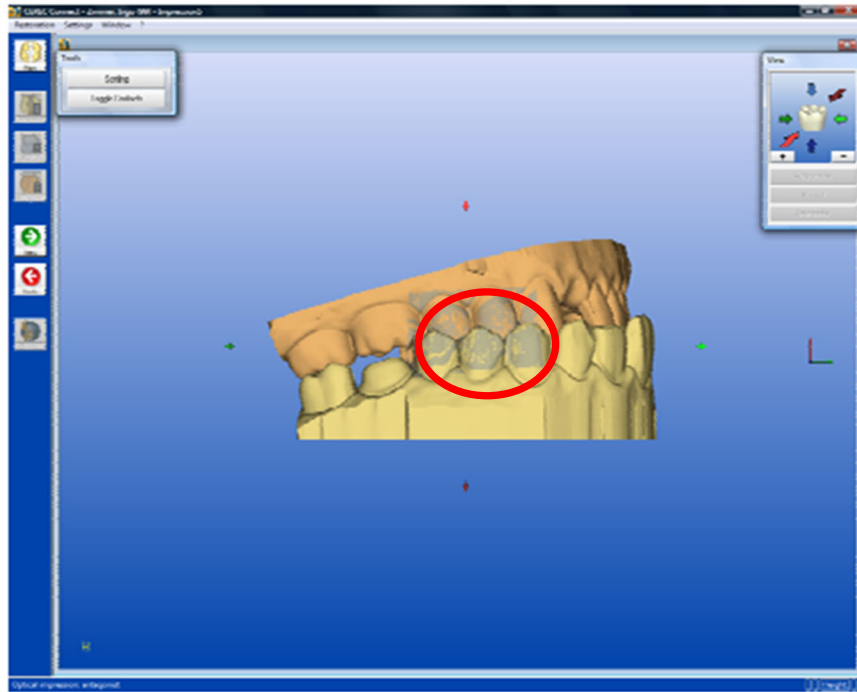
* * *

At Step S, *the global container is displayed to the user....
the global container is a digital representation of the
object...*

EX1008, 65:14-66:13 (emphasis added). That is, Rubbert discloses choosing the best 3D rigid transformation which corresponds to a best metric (e.g., transformation matrix $[T]$); and if the best metric goes below a predetermined threshold, accepting the corresponding 3D rigid transformation (e.g., accepting transformation matrix $[T]_2$ in step F and proceeding to step G of the exemplary cumulative registration process illustrated in Figures 40A-40B); if the best metric exceeds a predetermined threshold rejecting the stitching (e.g., rejecting transformation matrix $[T]_2$ and any such proposed stitching of frame 2 to frame 1 and the global container, and performing the registration process again until either the index/predetermined threshold is met or a new transformation matrix $[T]_2'$ is applied to frame 2). EX1009, ¶¶167-169.

6. Claim 9: The method of bite registration according to claim 1, wherein the teeth contained in the bite surface are selected from incisors, premolar or molars.

Sommer discloses the additional limitations of Claim 9. For example, Sommer visually depicts the alignment of premolar teeth (circled in red) in the bite surface of the bite registration that is correlated with the upper and lower jaws:



EX1005, 3; EX1009, ¶¶170-172.

7. **Claim 10: The method of bite registration according to claim 1, wherein the bite surface is acquired based on one or more bite views captured by a scanner.**

Sommer in combination with Rubbert discloses Claim 10. *See* §VII.A.2.a.; EX1009, ¶¶173-174.

8. **Claim 11: The method of bite registration according to claim 1, wherein the alignment is completed in a manual way, a semi-automatic way or automatic way.**

Sommer discloses the additional limitations of Claim 11. For example, Sommer describes both “a manual pre-correlation by the user combined with the final calculation done by the software.” EX1005, 1. Sommer further discloses that “[a]s far as known all products in this field using the buccal method [of correlation]

use an automatic correlation algorithm.” *Id.* Thus, Sommer discloses an alignment that is completed in both a manual way and an automatic way. EX1009, ¶¶175-179.

9. Claim 12: The method of bite registration according to claim 1, wherein the final bite registration is used to construct a global 3D teeth model.

Malfliet discloses the additional limitations of Claim 12. As discussed above, the combination of Sommer and Malfliet discloses a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations. *See* §VII.A.1.g. This final bite registration can be used in the construction of a global 3D teeth model as taught by Malfliet. For example, Malfliet discloses that

The image data 30 that has been acquired from the imaging sources 31-34 is used to generate a virtual, three-dimensional model 56 which is a life-like representation of at least the area of the human body to be treated. Typically, this area will be the patient’s jaw, teeth (if any are remaining) and soft tissue surrounding these parts, such as the gums....The extent of the 3D model can be restricted just to the area to be treated and the soft tissue immediately surrounding this area....

EX1006, ¶[0030]. Thus, Malfliet discloses that when the 3D model is extended to the entire face and head of the user, the 3D model is a global 3D model that includes at least the patient’s jaws and teeth. EX1009, ¶¶180-183.

Malfliet further discloses that “[t]he composite 3D model created [using the final bite registration]...should preferably include the face of the patient to allow facial analysis to be based on the model [and that the] 3D model used to plan a modified tooth set-up ... is useful to visualize to the user and patient the effects of the treatment and can be rendered in the final stage 66 of the method when a virtual representation of the tooth set-up following treatment is displayed to the user and a patient.” EX1006, ¶[0047]; EX1009, ¶¶184-185.

10. Claim 21 (Preamble): A method of bite registration, comprising:

Sommer discloses the Preamble of Claim 21. *See* §VII.A.1.; EX1009, ¶¶186-187.

a. [21.1]: a. generating 3-dimensional (3D) teeth models of the upper jaw and the lower jaw;

Sommer discloses Element [21.1]. *See* §VII.A.1.a.; EX1009, ¶¶188-189.

b. [21.2]: b. acquiring a bite surface containing a portion of the upper jaw and an opposing portion of the lower jaw simultaneously in a clenched state where the upper jaw is static relative to the lower jaw;

Sommer in combination with Rubbert discloses Element [21.2]. *See* §VII.A.1.b.; EX1009, ¶¶190-191.

c. [21.3]: c. attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface to achieve successful alignment;

Sommer discloses Element [21.3]. *See* §VII.A.1.c.; EX1009, ¶¶192-193.

- d. [21.4]: d. displaying the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface where successful alignment is achieved;**

Sommer discloses Element [21.4]. *See* §VII.A.1.d.; EX1009, ¶¶194-195.

- e. [21.5]: e. repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;**

Sommer discloses Element [21.5]. *See* §VII.A.1.e.; EX1009, ¶¶196-197.

- f. [21.6]: selecting two or more successful bite registrations by evaluating the at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and**

Sommer discloses Element [21.6]. *See* §VII.A.1.f.; EX1009, ¶¶198-199.

- g. [21.7]: computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and wherein step e, when repeating to perform step b, the location of the acquired bite surface is changed.**

Sommer in combination with Malfliet discloses Element [21.7]. *See* §VII.A.1.g.; EX1009, ¶¶200-201.

11. Claims 1, 5-12, and 21 Would Have Been Obvious

Claims 1, 5-12, and 21 would have been obvious over Sommer, Rubbert, and Malfliet. EX1009, ¶202.

a. Difference between the claimed invention and the prior art.

As discussed in §§VII.A.1-10., Sommer, Rubbert, and Malfliet together disclose all of the features of Claims 1, 5-12, and 21. While Sommer does not disclose the details of the hardware or software required to acquire and process images of a dentition for the generation of 3D teeth models, Rubbert discloses these missing limitations (*e.g.*, Elements [5.1]-[5.4], [8.1]-[8.3], and the additional limitations of Claim 7). Similarly, Rubbert expressly discloses acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously in a *clenched state* where the upper jaw is static relative to the lower jaw (*e.g.*, Elements [1.2] and [21.2]). EX1009, ¶¶203-204.

Sommer and Rubbert together disclose all of the features of Claims 1, 5-12, and 21, with the exception of the final computation of bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations. Malfliet discloses this missing limitation. EX1009, ¶¶205-206.

b. A POSITA would have had motivation to combine the disclosures of Sommer, Rubbert, and Malfliet.

A POSITA would have had a motivation to modify Sommer to (i) use the well-known hardware (*e.g.*, scanner and workstation) and software of Rubbert and

(ii) include the clenched dentition state of Rubbert. Further, a POSITA would have had a motivation to use the final computation of bite registration method of Malfliet with Sommer's method of correlating bite surfaces between the upper and lower jaws. EX1009, ¶¶207-209.

i. A POSITA would have been motivated to use the well-known hardware and software of Rubbert.

As discussed above, Sommer discloses a correlation method between upper and lower jaw digital impressions. EX1005, Title. Sommer emphasizes that for “the design of a dental restoration or orthodontic treatment planning, [the] upper and lower must be correlated.” *Id.*, 1. According to Sommer, “[c]apturing the digital impressions from the upper jaw and lower jaw with [a] dental scanning system is typically done separately.” *Id.* Sommer also states that the “method by taking the optical impressions from the bite is well known and technically solved.” *Id.*; EX1009, ¶¶210-212.

Rubbert discloses such a well-known and technically solved dental scanning system. EX1008, Abstract. Indeed, Rubbert discloses all of the hardware and software that is required to acquire and process images of a dentition. *Id.* Further, Rubbert describes and provides a flow chart illustrating the steps performed to generate a complete three-dimensional model of a patient's dentition from a series of scans of the upper and lower jaws (*e.g.*, frame registration and stitching). *Id.*, 18:9-

10 and FIG. 36. Furthermore, Rubbert discloses a “computer-interactive software program [that] provides for treatment planning, diagnosis and appliance from the [generated] virtual tooth models.” *Id.*, Abstract. Indeed, Rubbert explains that the “virtual model of the desired occlusion and the virtual model of the original dentition provide a base of information for custom manufacture of an orthodontic appliance.” *Id.*; EX1009, ¶¶213-215.

Thus, a POSITA would have been motivated to combine Sommer and Rubbert because (i) Rubbert supplies the dental scanning system that Sommer acknowledges is well-known in the art and technically solved and (ii) Rubbert discloses the means for generating high quality virtual 3D teeth models based upon which Sommer performs its correlations. EX1009, ¶216.

And, once a POSITA had motivation to combine the dental scanning system of Rubbert with the correlation method and system of Sommer, a POSITA would have relied on all aspects of Rubbert’s disclosure. That is, a POSITA would have had motivation to combine Sommer’s correlation process with Rubbert’s teachings of (i) scanning 3D teeth surfaces on the upper and lower jaws with a scanner (relates to Element [5.1]) , (ii) determining whether the scanned 3D teeth surface is the first one during the scan (relates to Element [5.2]), (iii) accepting such scans and combining such scans with a 3D teeth model (relates to Element [5.3]), (iv) registering such scan frames of 3D teeth surfaces onto existing 3D teeth models

(relates to Element [5.4] and the additional limitations of Claim 7), (v) generating candidate 3D rigid transformations to place the scanned 3D teeth surface relative to the 3D teeth model (related to Element [8.1]), (vi) evaluating a metric of the 3D rigid transformation using the relative placement of the 3D teeth surface relative to the 3D teeth model (related to Element [8.2]), (vii) selecting the best 3D rigid transformation corresponding to the best metric by accepting the 3D rigid transformation if the best metric is below a predetermined threshold value and rejecting the 3D rigid transformation if the best metric is above the predetermined threshold value (related to Element [8.3]) to meet all of the limitations of the independent and dependent claims discussed herein. EX1009, ¶217.

A POSITA would have also understood that the success of Sommer's correlation method depends on the accuracy of the underlying 3D models that it relies upon. Thus, a POSITA would have looked to references like Rubbert which explicitly disclose means for generating accurate 3D models using conventional methods like frame registration and stitching. EX1008, FIGs. 52-53; EX1009, ¶218.

A POSITA would also have been motivated to combine Sommer and Rubbert because they are in the same field of endeavor—aligning and correlating digital representations of teeth of upper and lower jaws for orthodontic treatment planning. EX1009, ¶219; *KSR*, 550 U.S. at 417.

ii. A POSITA would have been motivated to use the clenched dentition scan of Rubbert in Sommer's correlation method.

To facilitate treatment planning, “[a] bite registration scan is obtained from the patient to spatially correlate the scans of the upper and lower jaws when the *dentition is clenched*.” EX1008, 85:17-18 (emphasis added). Rubbert explains that “[t]his scan is used to provide a registration of the upper and lower jaw to determine the correct relative position.” *Id.*, 85:18-19. Rubbert further explains that “[t]his bite registration scan is usually needed at the beginning of a treatment to set the relation between the upper and lower jaws.” *Id.*, 85:19-21. Thus, Rubbert itself provides a POSITA with a motivation to use a clenched dentition scan in Sommer's correlation method between upper and lower jaw digital impressions, *i.e.*, to spatially correlate the scans of the upper and lower jaws so as to determine the correct relative position for appropriate treatment purposes. EX1009, ¶¶220-223; *KSR*, 550 U.S. at 418-419.

iii. A POSITA would have been motivated to use the final computation step of Malfliet in Sommer's correlation method.

While Sommer discloses a “solution [of] manual pre-correlation by the user combined with the final calculation done by the Software” (EX1005, 1), Sommer is silent regarding how the final calculation of “computing a final bite registration

between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations” is performed. EX1009, ¶224.

Malfliet, much like Sommer, discloses a “method for automatic, or semi-automatic, planning of dental treatment for a patient.” EX1006, Abstract. Malfliet discloses “obtaining data about an area which is to be treated” and “performing a computer-assisted analysis of the data” to “create[e] a modified tooth set-up using a set of stored rules.” *Id.* When combining data into a single virtual model, Malfliet describes “[a] final mapping [that] is performed [] by: a least-squares algorithm/n-point registration/ICP (Iterative Closest Point) registration, which will find the optimal transformation necessary to align both sets of points.” *Id.*, ¶[0044]. Malfliet references a number of journal articles at Paragraph [0038] that describe how “3D models are registered onto each other using a fully automatic registration algorithm based on feature recognition.” The underlying methodologies discuss ICP registration in even greater detail. Because Sommer states that “algorithms correlating the models are well known ICP based algorithms,” a POSITA would have looked to Malfliet for additional details regarding the use of such ICP based algorithms in computation/mapping of a final bite registration between the teeth models of the upper jaw and the lower jaw. EX1005, 1. That is, the combination of Sommer and Malfliet constitutes nothing more than prompting a variation of the Sommer correlation method with the known ICP final computation details of

Malfliet and/or combining familiar elements (*e.g.*, using an ICP algorithm) according to known methods (*e.g.*, inserting the algorithm into a correlation process). EX1009, ¶¶225-229; *KSR*, 550 U.S. at 401.

Finally, a POSITA would have been motivated to combine Sommer and Malfliet because they are in the same field of endeavor—aligning and correlating digital representations of teeth of upper and lower jaws for orthodontic treatment planning. EX1009, ¶230; *KSR*, 550 U.S. at 417.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Rubbert, Malfliet, and knowledge generally available in the art.

A POSITA would have had a reasonable expectation of success of making this combination because (i) the hardware and software for acquiring and processing images of a dentition in order to generate 3D models was well known in the art, (ii) there are only two possible ways to scan the upper and lower jaws, *i.e.*, in the clenched and unclenched states, and (iii) using the ICP algorithm in the correlation process of Sommer was already contemplated. EX1009, ¶231.

First, as Sommer readily admits, “method[s] by taking the optical impressions from the bite is well known and technically solved.” EX1005, 1. As of the priority date of the ’391 Patent, there were numerous dental scanners with associated software on the commercial market. EX1013, Abstract (listing CEREC AC, Cadent iTero, Lava COS). “Both the CEREC AC and the Cadent iTero capture single 3D

frames that are stitched with other frames to compose a complete 3D model in a short registration cycle.” *Id.*, e43313. Sommer also mentions that its software is contemplated for use with the CEREC product. EX1005, 1. As such, a POSITA would have had a reasonable expectation of successfully using not just Rubbert’s scanning hardware and registration software with Sommer’s method of bite surface alignment and registration, but any of the prior art dental scanning hardware and registration software. Thus, the combination of Sommer and Rubbert is no more than the application of known techniques to known devices ready for improvement to yield predictable results. EX1009, ¶232; *KSR*, 550 U.S. at 417.

Second, because there are only two possible ways to scan the upper and lower jaws, there are a finite number of identified, predictable solutions/orientations for scanning the dentition of a patient. EX1009, ¶¶233-234. As such, a POSITA would have had a “good reason to pursue the known options within his or her technical grasp.” *KSR*, 550 U.S. at 402.

Third, Sommer had already discussed using “well known ICP based algorithms” as part of its correlation process. EX1005, 1. Malfliet simply placed that ICP based algorithm in its “final mapping” step. EX1006, ¶[0044]. Accordingly, a POSITA would have understood the placement of an ICP based algorithm in the final computation/mapping step of Sommer as simply using a

“known method” that would have led to predictable results. EX1009, ¶¶235-236; *KSR*, 550 U.S. at 416.

For all of the foregoing reasons, Sommer, Rubbert, and Malfliet render obvious all the recited features of Claims 1, 5-12, and 21. EX1009, ¶237; *KSR*, 550 U.S. at 416.

B. Claims 2-4 Would Have Been Obvious Over Sommer in View of Rubbert, Malfliet, and Estépar (Ground 2).

The following sections explain where each element of Claims 2-4 is found in the prior art. EX1009, ¶238.

1. Claim 2: The method of bite registration according to claim 1, wherein the computation of the final bite registration involves the optimization of a cost function depending on the selected successful bite registrations.

The combination of Sommer, Malfliet, and Estépar discloses the additional limitations of Claim 2. Sommer discusses manual pre-correlation of the upper and lower jaw models with a bite registration before a final automatic software calculation:

The correlation between the upper and lower jaw by using buccal images can technically be calculated automatically by correlating corresponding areas on all images. But since the morphology details of the teeth on the buccal surface are very similar among each other,...the risk of mismatching models is increased. A solution can be a

manual pre-correlation by the user combined with the final calculation done by the software.

EX1005, 1. Sommer further notes that the “algorithms correlating the models are well known ICP based algorithms.” *Id.* Malfliet also contemplates the use of such ICP algorithms. EX1006, ¶¶[0038], [0044]. A POSITA would have known that ICP algorithms involve the optimization of a cost function based on knowledge in the prior art. For example, Estépar is referenced at ¶[0038] of Malfliet and is described as a technique for automatic registering 3D models based on feature recognition. EX1009, ¶¶239-243.

Estépar expressly discusses ICP algorithms and minimizing cost functions:

Iterative Closest Points

Let P be the data shape (source shape) and X the model shape (target shape) to be registered with. The data shape is decomposed in point set form, if not already available in that form. The model shape could originally be given in any representation but for our purpose we will assume that is also decomposed in a point set. Thus, let N_P , N_X be the number of points in the shapes. P and X are respectively defined by the N_P -tuple $P = \{p_1, p_2, \dots, p_{N_P}\}$ and the N_X -tuple $X = \{x_1, x_2, \dots, x_{N_X}\}$. There is not a preestablished correspondence between the points p_j and x_j .

ICP finds the rigid body transformation, rotation R and translation t that aligns the source with the target by minimizing the distance metric

$$J(R, t) = \sum_{i=1}^{NP} ||y_i - R p_i - t||^2, \text{ where } y_i = C(R p_i + t, X) \quad (1)$$

is a point on the surface of the target model X that corresponds to the point p_i .

EX1007, 235 (emphasis added). Here, “ICP finds the rigid body transformation ... that aligns the source with the target by minimizing the distance metric” of Formula (1), *i.e.*, the cost function. *Id.* “At each iteration a correspondence is established by means of the correspondence operator C .” *Id.* Estépar then states that the “transformation that minimizes a mean square metric is computed,” *i.e.*, computation occurs whereby the cost function is minimized. Thus, Estépar teaches minimizing (*e.g.*, optimizing) a cost function using an ICP algorithm. Thus, Sommer in combination with Malfliet, and Estépar discloses a computation of the final bite registration involving the optimization of a cost function depending on the selected successful bite registrations. EX1009, ¶¶243-249.

2. **Claim 3: The method of bite registration according to claim 1, wherein the computation of the final bite registration involves one or more matrix interpolations of the selected successful bite registrations.**

The combination of Sommer, Rubbert, Malfliet, and Estépar discloses the additional limitations of Claim 3. As discussed above, Sommer discusses manual

pre-correlation of the upper and lower jaw models with a bite registration before a final automatic software calculation. EX1005, 1. Sommer further notes that the “algorithms correlating the models are well known ICP based algorithms.” *Id.* Malfliet also contemplates the use of such ICP based algorithms. EX1006, ¶¶[0038], [0044]. A POSITA would have known that ICP algorithms involve interpolations of matrices based on knowledge in the prior art. For example, Estépar is referenced at ¶[0038] of Malfliet and is described as a technique for the automatic registering of 3D models based on feature recognition. EX1009, ¶¶250-255.

Estépar expressly discloses an ICP protocol that relies on matrix manipulation. For example, Estépar first discloses decomposing matrices associated with the data shape (“[t]he data shape is decomposed in point set form”) and model shape into an equivalent set of values (“The model shape could originally be given in any representation but for our purpose we will assume that is also decomposed in a point set.”). EX1007, 235; EX1009, ¶¶256-257.

Estépar discloses determining corresponding values from each set of values. As discussed above, Estépar discloses a cost function that is sought to be minimized, Formula (1). EX1007, 235. A component of Formula (1) is “*correspondence operator C*,” which is also “typically the closest point operator.” *Id.* Estépar explains that once “the transformation that minimizes a mean square metric is computed [i.e., minimizes the cost function of Formula (1)] ... the data points are

transformed using the computed transformation and the process is repeated until a minimum error threshold is achieved or a maximum number of iterations is reached.” *Id.* Once the transformation process is complete, interpolation between corresponding values from each set of values is performed to fill “missing data or gaps.” Rubbert also discloses the need to utilize interpolation to fill in missing data or gaps. EX1008, 76:3-4, FIG. 65. As such, Rubbert discloses such interpolation methods. *Id.*, 21:19-21, 42:20-25, 43:1-2, 53:14-25, 76:3-15. Thus, the combination of Estépar and Rubbert discloses interpolating corresponding values from each set of values (*e.g.*, point sets from the data shape and the model shape). EX1009, ¶¶258-262.

Thus, Sommer in combination with Rubbert, Malfliet and Estépar discloses a computation of the final bite registration involving one or more matrix interpolations of the selected successful bite registrations. EX1009, ¶¶263-264.

3. **Claim 4: The method of bite registration according to claim 3, wherein said one or more interpolations contain steps of: decomposing each matrix into an equivalent set of values; interpolating corresponding values from each set of values; and recomposing a matrix from the interpolated set of values.**

The combination of Sommer, Rubbert, Malfliet, and Estépar discloses the additional limitations of Claim 4. As discussed above, the combination of cited references discloses the computation of a final bite registration involving one or more matrix interpolations of the selected successful bite registrations, decomposing

each matrix into an equivalent set of values, and interpolating corresponding values from each set of values. *See* §VII.B.2.; EX1009, ¶¶265-266.

After interpolating corresponding values from each set of values (*e.g.*, point sets from the data shape and the model shape) based on the teachings of Estépar and Rubbert, the interpolated values of the matrices would need to be recomposed for the aligned bite surface of the 3D teeth models of the upper and lower jaw to be integrated into the 3D model for display purposes. To leave the interpolated corresponding values in point set form would render them useless for 3D model generation which requires x, y, and z coordinates. In one application, Malfliet expressly discloses that the “final step of the method displays a virtual representation of the treatment area, displaying the effect of the optimal tooth (and soft tissue) set-up.” EX1006, ¶[0062]; EX1009, ¶¶267-268.

Thus, Sommer in combination with Rubbert, Malfliet, and Estépar discloses a computation of the final bite registration involving one or more matrix interpolations of the selected successful bite registrations, wherein the one or more interpolations contain steps of: decomposing each matrix into an equivalent set of values; interpolating corresponding values from each set of values; and recomposing a matrix from the interpolated set of values. EX1009, ¶¶269-250.

4. Claims 2-4 Would Have Been Obvious

Claims 2-4 would have been obvious over Sommer, Rubbert, Malfliet, and Estépar. EX1009, ¶271.

a. Difference between the claimed invention and the prior art.

Claims 2-4 depend directly or indirectly from Claim 1, and their additional limitations are disclosed by Estépar as discussed in §§VII.B.1-3.; EX1009, ¶272.

b. A POSITA would have had motivation to combine the disclosures of Sommer, Rubbert, Malfliet, and Estépar.

As discussed in §VII.A.11.b., a POSITA would have had a motivation to combine the disclosures of Sommer, Rubbert, and Malfliet. A POSITA would have had a motivation to additionally combine the disclosure of Estépar with the combination of Sommer, Rubbert, and Malfliet because Malfliet expressly references Estépar for use in its processes and as disclosing an automatic registration algorithm based on feature recognition. EX1006, ¶[0038]; EX1009, ¶¶273-274; *KSR*, 550 U.S. at 418-419.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Rubbert, Malfliet, and Estépar and knowledge generally available in the art.

As discussed in §VII.A.11.c., a POSITA would have had a reasonable expectation of success of making the combination of Sommer, Rubbert, and Malfliet because (i) the hardware and software for acquiring and processing images of a

dentition in order to generate 3D models was well known in the art, (ii) there are only two possible ways to scan the upper and lower jaws, *i.e.*, in the clenched and unclenched states, and (iii) using the ICP algorithm in the correlation process of Sommer was already contemplated. A POSITA would have had a reasonable expectation of making the combination of Sommer, Rubbert, Malfliet, and Estépar because Estépar describes the details of ICP based registration algorithms that were “well known” and “extensively used” in the art (*i.e.*, known methods). EX1005, 1; EX1007, 234 (“The iterative closest point (ICP) algorithm *has been extensively used* as [an] optimization technique for rigid model based registration based on features extracted from medical datasets [Emphasis added].”) EX1009, ¶¶275-276; KSR, 550 U.S. at 416.

For all of the foregoing reasons, Sommer, Rubbert, Malfliet, and Estépar render obvious all the recited features of Claims 2-4. EX1009, ¶277.

C. Claims 13, 14, and 17-19 Would Have Been Obvious Over Sommer in View of Malfliet (Ground 3).

The following sections explain where each element of Claims 13, 14, and 17-19 is found in the prior art. EX1009, ¶278.

1. Claim 13 (Preamble): A system for bite registration, comprising:

Sommer discloses a method and system for bite registration. *See* §VII.A.1.; EX1009, ¶279.

- a. **[13.1]: means for generating 3D teeth models of the upper jaw and the lower jaw;**

Sommer discloses means for generating 3D teeth models of the upper jaw and the lower jaw. *See* §VII.A.1.a.; EX1009, ¶280.

- b. **[13.2]: means for acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously;**

Sommer discloses means for acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at least one opposing tooth of the lower jaw simultaneously. *See* §VII.A.1.b.; EX1009, ¶281.

- c. **[13.3]: means for attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;**

Sommer discloses means for attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface. *See* §VII.A.1.c.; EX1009, ¶282.

- d. **[13.4] means for displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;**

Sommer and Malfliet disclose means for displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful. *See* §VII.A.1.d. The combination of Sommer and Malfliet also discloses a computerized workstation and associated software as Patent Owner construes this element in §VI. *See, e.g.,* EX1005, 1 (“CEREC Product name

for the software for the dentist by SIRONA”) and EX1006, Abstract, FIG. 1; EX1009, ¶283.

- e. **[13.5] means for obtaining at least two successful bite registrations corresponding to different displayed bite surface by repeating;**

Sommer and Malfliet disclose means for obtaining at least two successful bite registrations corresponding to different displayed bite surface by repeating. *See* §VII.A.1.e. The combination of Sommer and Malfliet also discloses a computerized workstation and associated software as Patent Owner construes this element in §VI. EX1005, 1; EX1006, Abstract, FIG. 1; EX1009, ¶284.

- f. **[13.6] means for selecting two or more successful bite registrations by evaluating at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations; and**

Sommer and Malfliet disclose means for selecting two or more successful bite registrations by evaluating at least two successful bite registrations and selecting said two or more of the displayed successful bite registrations. *See* §VII.A.1.f. The combination of Sommer and Malfliet also discloses a computerized workstation and associated software as Patent Owner construes this element in §VI. EX1005, 1; EX1006, Abstract, FIG. 1; EX1009, ¶285.

- g. [13.7] means for computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations, and**

Sommer in combination with Malfliet discloses means for computing a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations. *See* §VII.A.1.g.; EX1009, ¶286.

- h. [13.8] wherein in step e, when repeating to perform step b, the location of the acquired bite surface is changed.**

Sommer discloses that the location of the acquired bite surface is changed in step e, when repeating to perform step b. *See* §VII.A.1.e. and VII.A.1.g.; EX1009, ¶¶287-288.

- 2. Claim 14: The system for bite registration according to claim 13, wherein the computation of the final bite registration involves the optimization of a cost function depending on the selected successful bite registrations.**

Sommer in combination with Malfliet discloses Claim 14. *See* §VII.B.1.; EX1009, ¶289.

- 3. Claim 17: The system for bite registration according to claim 13, wherein means for attempting to align the 3D teeth models includes: module for, if the alignment is not successful, discarding the bite surface and sending a notification of failing to align to the user.**

Sommer discloses the additional limitations of Claim 17. Sommer discloses that “[i]n case that the software cannot correlate the buccal images [bite surfaces]

with either the upper jaw or lower jaw, the user has to take additional images or ***remove not useful images*** until the software can calculate the correlation [emphasis added].” EX1005, 1. Thus, Sommer discloses a module for, if the alignment is not successful, discarding the bite surface. Sommer also discloses sending a notification of failing to align to the user. For example, Sommer states that “[i]f the correlation was not successful, the buccal model shakes for a moment and stays in the middle between the models.” *Id.*, 2. When the buccal model shakes and stays in the middle between the upper and lower jaw models, the user is notified of an alignment/correlation failure. EX1009, ¶¶290-296.

4. Claim 18 (Preamble): A system for bite registration, including a scanner and a computerized workstation, wherein the workstation is configured as:

Sommer in combination with Malfliet discloses the Preamble of Claim 18. *See* §§VII.A.2., VII.A.2.a., VII.C.1. Malfliet also discloses a system for bite registration that includes a computerized workstation. EX1006, ¶[0029] and FIG. 1; EX1009, ¶¶297-298.

a. [18.1]: obtaining 3D teeth models of the upper jaw and the lower jaw, generated respectively, by the scanner;

Sommer in combination with Malfliet discloses Element [18.1]. *See* §VII.A.2.a.; EX1009, ¶299.

b. [18.2]: acquiring a bite surface containing a portion of at least one tooth of the upper jaw and a portion of at

**least one opposing tooth of the lower jaw
simultaneously in a clenched state where the upper
jaw is static relative to the lower jaw;**

Sommer in combination with Rubbert discloses Element [18.2]. *See* §VII.A.1.b.; EX1009, ¶300.

- c. [18.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface at the workstation;**

Sommer discloses Element [18.3]. *See* §VII.A.1.c.; EX1009, ¶301.

- d. [18.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;**

Sommer discloses Element [18.4]. *See* §VII.A.1.d.; EX1009, ¶302.

- e. [18.5]: repeating steps acquiring to step of displaying so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;**

Sommer discloses Element [18.5]. *See* §VII.A.1.e.; EX1009, ¶303.

- f. [18.6]: selecting two or more successful bite registrations by evaluating at least two successful bite registrations; and**

Sommer discloses Element [18.6]. *See* §VII.A.1.f.; EX1009, ¶304.

- g. [18.7]: computing a final bite registration using the selected two or more successful bite registrations, and where in the repeating step, when repeating to perform the acquiring step, the location of the acquired bite surface is changed.**

Sommer in combination with Malfliet discloses Element [18.7]. *See* §VII.A.1.g.; EX1009, ¶¶305-306.

- 5. Claim 19: The system for bite registration according to claim 18, wherein the system is used to construct a global 3D teeth model.**

Sommer in combination with Malfliet discloses Claim 19. *See* §VII.A.9.; EX1009, ¶307.

- 6. Claims 13, 14, and 17-19 Would Have Been Obvious**

Claims 1-21 would have been obvious over Sommer and Malfliet. EX1009, ¶308.

- a. Difference between the claimed invention and the prior art.**

As discussed in §§VII.C.1-5., Sommer and Malfliet together disclose all of the features of Claims 13, 14, and 17-19. Sommer discloses all of the features of Claims 13, 14, and 17-19, with the exception of the final computation of bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations. Malfliet discloses this missing limitation. EX1009, ¶¶309-310.

b. A POSITA would have had motivation to combine the disclosures of Sommer and Malfliet.

A POSITA would have had a motivation to use the computation of a final bite registration method of Malfliet with Sommer's method of correlating bite surfaces between the upper and lower jaws. EX1009, ¶311.

Malfliet, much like Sommer, discloses a “method for automatic, or semi-automatic, planning of dental treatment for a patient.” EX1006, Abstract. Malfliet discloses “obtaining data about an area which is to be treated” and “performing a computer-assisted analysis of the data” to “create[e] a modified tooth set-up using a set of stored rules.” *Id.* When combining data into a single virtual model, Malfliet describes “[a] final mapping [that] is performed [] by: a least-squares algorithm/n-point registration/ICP (Iterative Closest Point) registration, which will find the optimal transformation necessary to align both sets of points.” *Id.*, ¶[0044]. Malfliet references a number of journal articles at Paragraph [0038] that describe how “3D models are registered onto each other using a fully automatic registration algorithm based on feature recognition.” The underlying methodologies discuss ICP registration in even greater detail. EX1009, ¶¶312-315.

Because Sommer states that “algorithms correlating the models are well known ICP based algorithms,” a POSITA would have looked to Malfliet for additional details regarding the use of such ICP based algorithms in computation/mapping of a final bite registration between the teeth models of the

upper jaw and the lower jaw. EX1005, 1. That is, the combination of Sommer and Malfliet constitutes nothing more than prompting a variation of the Sommer correlation method with the known ICP final computation details of Malfliet and/or combining familiar elements (*e.g.*, using an ICP algorithm) according to known methods (*e.g.*, inserting the algorithm into a correlation process). EX1009, ¶¶316-317; *KSR*, 550 U.S. at 401.

Finally, a POSITA would have been motivated to combine Sommer and Malfliet because they are in the same field of endeavor—aligning and correlating digital representations of teeth of upper and lower jaws for orthodontic treatment planning. EX1009, ¶318; *KSR*, 550 U.S. at 417.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Malfliet, and knowledge generally available in the art.

A POSITA would have had a reasonable expectation of success of making this combination because using the ICP algorithm in the correlation process of Sommer was already contemplated. EX1009, ¶319.

Sommer had already discussed using “well known ICP based algorithms” as part of its correlation process. EX1005, 1. Malfliet simply placed that ICP based algorithm in its “final mapping” step. EX1006, ¶[0044]. Accordingly, a POSITA would have understood the integration of an ICP based algorithm in the final

computation/mapping step of Sommer as simply using a well “known method” that would have led to predictable results. EX1009, ¶¶320-321; *KSR*, 550 U.S. at 416.

For all of the foregoing reasons, Sommer and Malfliet render obvious all the recited features of Claims 13, 14, and 17-19. EX1009, ¶322.

D. Claims 15, 16, and 20 Would Have Been Obvious Over Sommer in View of Malfliet and Estépar (Ground 4).

The following sections explain where each element of Claims 15, 16, and 20 is found in the prior art. EX1009, ¶323.

1. **Claim 15: The system for bite registration according to claim 13, wherein means for computing the final bite registration involves device for one or more matrix interpolations of the selected successful bite registrations.**

Sommer in combination with Malfliet and Estépar discloses Claim 15. *See* §VII.B.2.; EX1009, ¶324.

2. **Claim 16: The system for bite registration according to claim 15, wherein device for one or more matrix interpolations includes: module for decomposing each matrix into an equivalent set of values; module for interpolating corresponding values from each set of values; and module for recomposing a matrix from the interpolated set of values.**

Sommer in combination with Malfliet and Estépar discloses Claim 16. *See* §VII.B.3.; EX1009, ¶325.

3. **Claim 20 (Preamble): A method of bite registration, characterized by comprising the steps of:**

Sommer discloses the Preamble of Claim 20. *See* §VII.A.1.; EX1009, ¶326.

- a. **[20.1]: generating 3-dimensional (3D) teeth models of the upper jaw and the lower jaw;**

Sommer discloses Element [20.1]. *See* §VII.A.1.a.; EX1009, ¶327.

- b. **[20.2]: acquiring a bite surface containing a part of at least one tooth of the upper jaw and a part of at least one opposing tooth of the lower jaw simultaneously;**

Sommer discloses Element [20.2]. *See* §VII.A.1.b.; EX1009, ¶328.

- c. **[20.3]: attempting to align the 3D teeth models of the upper jaw and the lower jaw with the bite surface;**

Sommer discloses Element [20.3]. *See* §VII.A.1.c.; EX1009, ¶329.

- d. **[20.4]: displaying the bite surface together with the 3D teeth models of the upper jaw and the lower jaw aligned with the bite surface if alignment is successful;**

Sommer discloses Element [20.4]. *See* §VII.A.1.d.; EX1009, ¶330.

- e. **[20.5]: repeating step b to step d so as to obtain at least two successful bite registrations corresponding to different displayed bite surfaces;**

Sommer discloses Element [20.5]. *See* §VII.A.1.e.; EX1009, ¶331.

- f. **[20.6]: selecting one or more successful bite registrations by evaluating at least two successful bite registrations; and**

Sommer discloses Element [20.6]. *See* §VII.A.1.f.; EX1009, ¶¶332.

- g. [20.7]: computing a final bite registration using selected one or more successful bite registrations, wherein the computation of the final bite registration involves one or more matrix interpolations of the selected successful bite registrations.**

Sommer in combination with Malfliet and Estépar discloses Element [20.7].

See §§VII.A.1.g., VII.B.2; EX1009, ¶¶333-334.

4. Claims 15, 16, and 20 Would Have Been Obvious

Claims 1-21 would have been obvious over Sommer, Malfliet, and Estépar. EX1009, ¶335.

- a. Difference between the claimed invention and the prior art.**

Claims 15 and 16 depend directly or indirectly from Claim 13, and their additional limitations are disclosed by Estépar as discussed in §§VII.D.1-2. Regarding Claim 20, Sommer does not expressly disclose the details of a computation of a final bite registration between the teeth models of the upper jaw and the lower jaw using the selected two or more displayed successful bite registrations. Malfliet discloses this missing limitation. EX1009, ¶336.

The combination of Sommer and Malfliet does not disclose the computation of the final bite registration involving one or more matrix interpolations of the selected successful bite registrations. Estépar discloses this missing limitation. EX1009, ¶337.

b. A POSITA would have had motivation to combine the disclosures of Sommer, Malfliet, and Estépar.

As discussed in §VII.C.6.b., a POSITA would have had a motivation to combine the disclosures of Sommer and Malfliet. A POSITA would have had a motivation to additionally combine the disclosure of Estépar with the combination of Sommer and Malfliet because Malfliet expressly references Estépar for use in its processes and as disclosing an automatic registration algorithm based on feature recognition. EX1006, ¶[0038]; EX1009, ¶¶338-339; *KSR*, 550 U.S. at 418-419.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Sommer, Malfliet, and Estépar and knowledge generally available in the art.

As discussed in §VII.C.6.c., a POSITA would have had a reasonable expectation of success of making the combination of Sommer and Malfliet because using the ICP algorithm in the correlation process of Sommer was already contemplated. A POSITA would have had a reasonable expectation of making the combination of Sommer, Malfliet, and Estépar because Estépar describes the details of ICP based algorithms that were “well known” and “extensively used” in the art (*i.e.*, known methods). EX1005, 1; EX1007, 234 (“The iterative closest point (ICP) algorithm *has been extensively used* as [an] optimization technique for rigid model based registration based on features extracted from medical datasets [Emphasis added].”) EX1009, ¶¶340-341; *KSR*, 550 U.S. at 416.

For all of the foregoing reasons, Sommer, Malfliet, and Estépar render obvious all the recited features of Claims 15, 16, and 20. EX1009, ¶342; *KSR*, 550 U.S. at 416.

VIII. OTHER CONSIDERATIONS

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

All elements of Claims 1-21 are known in the art, and any differences between the claims of the '391 Patent and Sommer, Rubbert, Malfliet, and Estépar would have been obvious to a POSITA based on the disclosures of the applied references and the knowledge in the art.

Petitioners are not aware of any secondary considerations evidence bearing any nexus to the purported claimed invention. Any purported evidence of secondary considerations that Patent Owner may present in this proceeding would be insufficient to overcome the strong evidence of obviousness of Claims 1-21. EX1009, ¶343.

B. The Board Should Not Deny This Petition Under §314(a)

Petitioners hereby stipulates that, should the Petition be granted, Petitioners will not pursue in the Related Litigation the same grounds that are raised or could have reasonably been raised in this Petition pursuant to *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020). The Director has stated that “the PTAB will not discretionarily deny institution of an IPR” in view of

such a stipulation. Katherine K. Vidal, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (June 21, 2022) at 3 and n.3 (discussing Sotera); *see id.* at 7–9.

Accordingly, Petitioners’ stipulation is dispositive in establishing that institution should not be discretionarily denied under 35 U.S.C. §314(a).

C. The Board Should Not Deny This Petition Under §325(d)

There is no reason to deny institution under §325(d). The totality of the *Becton, Dickinson* factors favor institution. Specifically, none of the cited references herein is the same or substantially the same art previously addressed by the examiner during prosecution of the application.

IX. CONCLUSION

For at least the foregoing reasons, Claims 1-21 of the ’391 Patent are unpatentable. Since Petitioners have shown the claims to be *prima facie* obvious, Petitioners have also shown a likelihood of success on the merits. Therefore, this Petition should be granted, and the Board should institute trial.

Respectfully submitted,

Date: February 15, 2024

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APPENDIX A—LIST OF EXHIBITS

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 10,076,391, issued on September 18, 2018 to Y. Glinec <i>et al.</i> (“the ’391 Patent”)
1002	File History of U.S. Patent Application No. 14/770,177, filed on August 25, 2015
1003	PCT International Publication No. WO 2014/139078, published on September 18, 2014
1004	Defendant’s Answer to Plaintiff’s Second Amended Complaint, Defenses, and Counterclaims, filed on February 16, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829
1005	Veröffentlicht durch SOMMER IP Office “Correlation between upper and lower jaw of digital impressions” (5 pages) (August 2010) (“Sommer”)
1006	U.S. Patent Publication No. 2010/0145898, published June 10, 2010 to K. Malfliet (“Malfliet”)
1007	R. S.J. Estépar <i>et al.</i> , “Robust Generalized Total Least Squares Iterative Closest Point Registration,” Conference Paper: Medical Image Computing and Computer-Assisted Intervention -- MICCAI 2004, 7th International Conference Saint-Malo, France, September 26-29, 2004, Proceedings, Part I, LNCS 3216, pp. 234-241 (2004)
1008	PCT International Publication No. WO 01/80761, published on November 1, 2001 (“Rubbert”)
1009	Declaration of Eli Saber, Ph.D.
1010	<i>Curriculum Vitae</i> of Eli Saber, Ph.D.
1011	Declaration of Sylvia Hall-Ellis, Ph.D.

Petition for *Inter Partes* Review of U.S. Patent No. 10,076,391

EXHIBIT	DESCRIPTION
1012	<i>Curriculum Vitae</i> of Dr. Sylvia Hall-Ellis, Ph.D.
1013	W. J. van der Meer <i>et al.</i> , “Application of Intra-Oral Dental Scanners in the Digital Workflow of Implantology,” 7(8) PLOS ONE e43312 (6 pages) (August 2012)
1014	Counterclaim Defendant 3Shape A/S’ Opening Brief on Claim Construction, filed on October 27, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829
1015	DITC’s Opening Claim Construction Brief Regarding the DITC Asserted Patents, filed on October 27, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829

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

I hereby certify that the word count for the foregoing Petition totals 13,892 words, excluding the parts which are exempted by 37 C.F.R. §42.24(a)(1).

Date: February 15, 2024

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 15th day of February, 2024, a true and correct copy of the foregoing **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 10,076,391 B2 UNDER 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.* and EXHIBITS 1001–1015** are being served by overnight UPS on the correspondence address of record and the Assignee as follows:

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