

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CLEARCORRECT OPERATING LLC,
Petitioner,

v.

ALIGN TECHNOLOGY, INC.,
Patent Owner.

Case No. IPR2025-00817
Patent No. 10,791,936

DECLARATION OF HASSAN FOROOSH, PH.D.

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I, Hassan Foroosh, declare as follows:

I. QUALIFICATIONS

1. I am a Professor of Computer Science at the University of Central Florida. My primary research interests include image/video processing, computer vision, machine learning, and image-based modeling, including 3D modeling.

2. I received my Ph.D. in Computer Science from INRIA (French National Institute for Research on Informatics and Control), University of Nice Sophia Antipolis in 1996. I also earned a Master of Science in Computer Science from the University of Nice Sophia Antipolis in 1993, a Master of Science in Electrical Engineering from Kingston University, U.K., in 1990, and a Bachelor of Science in Electrical Engineering from Kingston University, U.K., in 1989.

3. Prior to research and teaching, I worked as an R&D Engineer at Innovative Engineering Solutions Ltd. in London from 1990 to 1992. Between 1993 and 1996, I served as a Research Assistant in the Scene Analysis and Symbolic Image Processing Group of INRIA, where I performed research in areas such as 3D super-resolution, imaging processes for registration, and shape perception. From 1997 to 2000, I served as an Assistant Research Scientist at the University of Maryland, College Park, where I investigated topics such as image registration (2D and 3D), super-resolution of video data for unmanned aerial vehicles, super-resolution of Synthetic Aperture Radar (SAR) and Foliage

Penetrating SAR (FOPEN-SAR), Automatic Target Detection and Tracking (ATD/R). Between 2000 to 2002, I served as Senior Research Scientist at the University of California, Berkeley where I also served as the Technical Coordinator and Principal Research Scientist of a Multi-University Research Initiative (MURI) funded by the Office of Naval Research. As part of the project, I conducted research on multi-sensor acquisition of 3D data for autonomous 3D modeling and visualization.

4. I joined the Department of Computer Science at the University of Central Florida (UCF) as an Assistant Professor in 2002. Since then, I have served as an Associate Professor, Professor, and CAE Link Professor of Computer Science in the same department. I also served in various capacities in the department, such as the Graduate Program Coordinator, chair of various leadership committees, and most recently in the Faculty Senate Strategic Planning Council for UCF. I have taught a number of courses directed to computer vision and 3D modeling, including: 3D Computer Vision, Image Processing, Special Topics in 3D Computer Vision, and Visual Simulation.

5. I have conducted extensive research in the field of 3D computer vision and computer modeling. Some example research projects that I have conducted include *Video Analysis Techniques for Terrain Modeling and Automated Texture Mapping* (2006-2007) and *Modeling and Visualization of*

Musculoskeletal Structures in Dental CT-Scan (2006-2007). For the latter project, I developed algorithms for 3D registration, modeling and visualization of maxilla and mandible of patients for dental surgery using Computer Aided Tomography (CAT) scanning.

6. I have been the principal investigator or co-principal investigator of numerous research projects funded by the National Science Foundation (NSF), NASA, DoD, and industry, with total funding exceeding \$14M since joining UCF. As one example, I served as the principal investigator in two projects funded by the National Science Foundation (NSF) on 3D modeling and the role of 3D information in machine understanding of digitized world. One project was directed to the registration/alignment of dental CT scans of patients over a period of time during the treatment of a patient, with the purpose of improving the quality of 3D models, *e.g.*, corrections and noise removal in 3D CT scans.

7. I have authored or co-authored around 200 articles in peer reviewed journals or conference proceedings. Some example publications include M. Berthod, H. Shekarforoush (Frooth), M. Werman and J. Zerubia, *Reconstruction of High Resolution 3D Visual Information*, Proc. IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pages. 654-657 (1994); C. Früh, J. Flynn, H. Frooth, and A. Zakhor, *Fast 3D model generation for urban environments*, Workshop on the Convergence of Graphics, Vision, and Video (CGVV'01),

Berkeley, March 2001; Jiangjian Xiao, Xiaochun Cao, and Hassan Foroosh, *3D Object Transfer Between Non-Overlapping Videos*, Proceedings of IEEE Virtual Reality Conference, pages 127-134, (March 25-29, 2006); M. Balci, M. Alnasser, and H. Foroosh, *Subpixel Alignment of MRI Data Under Cartesian and Log-Polar Sampling*, Proceedings of IAPR International Conference on Pattern Recognition (ICPR), vol.3, pages 607-610 (2006); M. Balci, M. Alnasser, and H. Foroosh, *Alignment of Maxillofacial CT Scans to Stone-Cast Models Using 3D Symmetry for Backscattering Artifact Reduction*, Medical Image Understanding and Analysis Conference (MIUA) (2006); A. Tariq and H. Foroosh, *Designing a Symmetric Classifier for Image Annotation using Multi-Layer Sparse Coding*, Image and Vision Computing (IVC) (2018); and several papers on processing 3D scan data published recently in venues such as CVPR, ECCV, AAAI, and ICRA.

8. Since joining UCF, I have advised and chaired the dissertation of over 30 doctoral students, 28 of whom have already successfully defended their doctoral dissertation, and secured academic positions or industry jobs in major high-tech corporations. As one example, I served as the advisor for a dissertation directed to “*Sub-pixel Registration in Computational Imaging and Applications to Enhancement of Maxillofacial CT Data.*” This research project focused on registration and alignment of 2D images and 3D digitized data obtained by dental CT scans and dental imprints of a patient (*e.g.*, casts), with the aim of improving

the quality of CT scans, e.g., eliminating backscattering issues. Methods were developed to register CT models to the physical imprints of patients (*e.g.*, a stone cast model of the patient's teeth).

9. I have been serving as the editor and/or committee member on numerous professional organizations. For instance, I have been involved with the following organizations: IEEE Transactions on Image Processing (Associate Editor, 2003-2008, 2011-2016); IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (Member, Technical Committee, 2004-2012, 2015-2016, 2019-2020); IEEE Transactions on Pattern Analysis and Machine Intelligence (Reviewer, 1996-present).

10. For my work, I have been honored with numerous awards, including the *Piero Zamperoni Award*, International Association for Pattern Recognition (IAPR) (2004). I have also received several Best Paper awards, including "*The Best Scientific Paper Award*" in the IAPR International Conference on Pattern Recognition in 2008, "*The Best Paper Award*" in the IEEE International Conference on Image Processing (ICIP) in 2018, and the *Distinguished Researcher*, UCF College of Engineering and Computer Science (2004-2005, 2005-2006).

11. For a more detailed listing of my credentials and publications, please see my *curriculum vitae* (EX2012).

II. SCOPE OF WORK

12. I have been retained by counsel for Align Technology, Inc. (“Align”), as an expert witness in the above-captioned proceeding. I understand that ClearCorrect Operating LLC (“Petitioner” or “ClearCorrect”), filed a petition with the United States Patent and Trademark Office for *inter partes* review of U.S. Patent No. 10,791,936 (EX1001, “the ’936 patent”), the subject of this proceeding.

13. I further understand that the Patent Trial and Appeal Board (the “Board”) has decided to institute *inter partes* review of claims 1-20 of the ’936 patent under 35 U.S.C. §103 based on International App. Pub. No. WO2007/084727 (EX1004, “Boerjes”), U.S. Patent No. 7,474,932 (EX1005, “Geng”), and U.S. Patent App. Pub. No. 2005/0283065 (EX1006, “Babayoff”). I understand the petition challenges the claims of the ’936 patent based on the following grounds:

Ground	Claims	Basis
1	1, 4-6, 8-12, 14-16	Obvious over Boerjes
2	1, 4-6, 8-12, 14-16	Obvious over Boerjes and Geng
3	2-3, 7, 13, 17-20	Obvious over Boerjes and Babayoff
4	2-3, 7, 13, 17-20	Obvious over Boerjes, Geng, and Babayoff

14. I have been specifically asked to provide my expert opinions on the patentability of the claims of the ’936 patent in view of the grounds asserted in the

petition. In connection with this analysis, I have reviewed the '936 patent and the prior art cited against the patentability of claims 1-20 of the '936 patent. I have also reviewed and considered the petition, Dr. Lina Karam's declaration (EX1003), the Board's institution decision, as well as various references cited in my declaration.

15. I am being compensated at a rate of \$650 per hour for my services in this matter. My compensation is not contingent upon the outcome of this matter or the specifics of my testimony.

III. LEGAL PRINCIPLES

16. I have been advised that the burden is on the Petitioner to demonstrate the unpatentability of the challenged claims, which must be proven by a preponderance of the evidence. This burden of proof applies to each factual matter in each ground raised in the petition, including specific arguments raised by the Petitioner regarding patentability.

17. I am informed that the pre-AIA text of 35 U.S.C. §§102 and 103 are applicable to this proceeding. For example, I have been advised that anticipation under 35 U.S.C. §102 is about prior invention and therefore a single prior art reference must be found to disclose all elements of the claimed invention arranged as in the claim. I have been further advised that it is not enough that the prior art references include multiple, distinct teachings that may somehow be combined to

achieve the claimed invention. Rather, it is my understanding that the reference must clearly and unequivocally disclose the claimed invention or direct a person of ordinary skill in the art to the claimed invention without any need for picking, choosing, and combining various disclosures that are not directly related to each other in the reference.

18. I understand that differences between the prior art reference and a claimed invention, however slight, invoke the question of obviousness, not anticipation.

19. I have been advised that a claimed invention is not patentable under 35 U.S.C. §103 if it is obvious. I understand that a claimed invention is unpatentable for obviousness if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to the person of ordinary skill in the art, in view of the prior art. The U.S. Supreme Court set out the framework for the obviousness inquiry as follows:

The scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others,

etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.

20. I have further been advised that the ultimate conclusion of whether a claim is obvious should be based upon several factual determinations. That is, a determination of obviousness requires inquiries into: (1) the level of ordinary skill in the field; (2) the scope and content of the prior art; (3) what difference, if any, existed between the claimed invention and the prior art; and (4) any objective indicia of nonobviousness.

21. I have been advised that, in determining the level of ordinary skill in the field that someone would have had at the time the claimed invention was made, I should consider: (1) the levels of education and experience of persons working in the field; (2) the types of problems encountered in the field; and (3) the sophistication of the technology.

22. I have been advised that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. In evaluating whether such a claim would have been obvious, I may consider whether there is a reason that would have prompted a person of ordinary skill in the art (“POSITA”) to combine the elements or concepts from the prior art in the same way as in the claimed invention.

23. I have also been advised, however, that I must be careful not to determine obviousness using the benefit of hindsight; many true inventions might seem obvious after the fact. I should put myself in the position of a POSITA at the time the claimed invention was made and I should not consider what is known today or what is learned from the teaching of the patent.

24. I have been advised that any obviousness rationale for modifying or combining prior art must include a showing that a POSITA would have had a reasonable expectation of success.

IV. SUMMARY OF THE '936 PATENT

25. I understand that the '936 patent issued from a series of applications and claims priority to a provisional application filed July 19, 2010. Below, I provide a summary of the '936 patent specification and claims, along with a summary of the '936 patent's prosecution and prior Board proceeding.

A. The '936 patent specification and claims

26. The '936 patent describes improved systems and methods for the preparation of orthodontics and prosthodontics. EX1001 ('936 patent), Abstract, 3:11-25. For example, 3D virtual representations are useful in prosthodontics, in which the model is used to design and manufacture a coping and/or a prosthesis, such as a crown or bridge, for mounting onto a prepared tooth. EX1001, 1:41-49. To manufacture the prosthesis, accuracy of the 3D model is needed. *See id.*, 1:50-

59. However, the '936 patent recognizes that there may be instances where the 3D scan is accurate, but the scan reveals that the preparation of the dentition is inadequate, such as where “the form of the preparation would result in an inadequate structure for the prosthesis” (*e.g.*, the dental preparation is too long, which would result in the thickness of the crown at the cusp being too thin and thus mechanically weak). *See id.*, 16:22-29. In these instances, the preparation needs to be subsequently modified after obtaining the virtual model, resulting in a change inside the patient’s mouth. *Id.*, 2:12-17. Prior to the '936 patent, “[s]uch situations would conventionally require a rescanning of the entire physical item.” *Id.*, 2:17-22. By requiring an entirely new scan, the process involved significant additional time, inconvenience, and patient discomfort. *Id.*

27. Contrary to the conventional approach at the time, the '936 patent describes systems and methods that utilize a multi-step selective scanning and merging workflow to generate high-quality 3D models that are useful for orthodontics and prosthodontics applications. For example, during the course of preparing the patient for a dental prosthesis, the intraoral cavity of a patient is first scanned to generate an accurate three-dimensional virtual model of the prepared teeth (*e.g.*, a “first virtual model”). *Id.*, 17:48-67, FIG. 1. Analysis of the virtual model may reveal that, while the prepared dentition “is well defined in the virtual model,” it may not be “suitable for the dental procedure.” *Id.*, 16:17-21. In such a

case, the user can identify the part of the virtual model that corresponds to the unsuitable part of the dental preparation by demarcating the area on a display. *Id.*, 16:36-38, 21:18-29. This informs the system of the portion of the virtual model that should be retained and the portion that should be removed. *Id.*, 21:30-59.

28. Next, the dental preparation itself is modified in the area found to be unsuitable (*e.g.*, by physically altering the dental preparation, such as by a “material removal operation” that modifies the topology of the tooth”) and “the preparation is scanned in the newly worked area.” *Id.*, 6:3-12, 16:40-44; *see also id.*, 22:36-60. This new scan data (*e.g.*, second scan data) is incorporated into the virtual model to form a “composite” 3D virtual model where part of the model is generated from scan data obtained prior to physically modifying the patient’s teeth and another part of the model (*i.e.*, the section removed by the user) is generated from scan data obtained after the physical modification (*e.g.*, after alteration or removal of a surface when changing a tooth preparation). *See id.*, 22:61-23:26, FIGS. 1, 9. The ’936 patent explains that this provides an efficient workflow process for producing an accurate 3D virtual model suitable for manufacturing accurate dental prostheses, while reducing the time, inconvenience, and patient discomfort needed to obtain the model. *See id.*, 16:66-17:3, 27:51-65.

29. I understand that the ’936 patent has 20 claims. Claims 1, 9, and 17 are independent. For reference, I have reproduced each of the independent claims

below. I have added the identifying labels in brackets that Petitioner and Dr. Karam use to refer to the limitations individually.

30. Claim 1 recites:

1[pre] A system for scanning a patient's teeth for a dental procedure, the system comprising:

1[a] a hand-held intraoral scanner; and

1[b] a computer readable medium including instructions that when executed by a computer system, cause the computer system to:

1[c] receive first scan data of the patient's teeth from the hand-held intraoral scanner;

1[d] display, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

1[e] receive user input defining a portion of the model to be removed;

1[f] remove, from the displayed model, a removed surface portion of the model to be removed according to the user input;

1[g] receive second scan data of the patient's teeth from the hand-held intraoral scanner, the second scan data including surface data of a physically changed portion of the patient's intraoral cavity;

1[h] replace at least a portion of the removed surface portion of the model using the received second scan data of the patient's teeth including surface data of a physically changed portion of the patient's intraoral cavity; and

1[i] output, to the display, the model of the patient's teeth with the portion of the removed surface portion replaced using the received second scan data.

31. Claim 9 recites:

9[pre] A method for scanning a patient's teeth for a dental procedure, the method comprising:

9[a] receiving first scan data of the patient's teeth from a hand-held intraoral scanner;

9[b] displaying, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

9[c] receiving user input via the displayed model demarcating a portion of the model to be retained and a surface portion of the model to be replaced;

9[d] receiving second scan data of the patient's teeth from the hand-held intraoral scanner, the second scan data including surface data of a physically changed portion of the patient's intraoral cavity;

9[e] replacing at least a portion of the surface portion of the model to be replaced according to the user input using at least a portion of the second scan data of the patient's teeth including the physically changed portion; and

9[f] outputting, to the display, the model of the patient's teeth with the at least the portion of the surface portion replaced using the second scan data.

32. Claim 17 recites:

17[pre] A system for intraorally scanning a patient's teeth for a dental procedure, the system comprising:

17[a] a hand-held intraoral scanner; and

17[b] a computer readable medium including instructions that when executed by a computer system, cause the computer system to:

17[c] receive first scan data of the patient's teeth from the hand-held intraoral scanner;

17[d] display, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

17[e] receive user input defining a portion of the model to be removed;

17[f] after receiving the user input, remove, from the displayed model, a removed surface portion of the model to be removed according to the user input;

17[g] after removing the portion of the model, receive second scan data of the patient's teeth from the hand-held intraoral scanner;

17[h] register the second scan data with the model by aligning identifying data of the second scan data with corresponding parts of the model;

17[i] replace at least a portion of the removed surface portion of the model using at least a portion of the received second scan data of the patient's teeth;

17[j] discarding a remainder of the second scan data, including the identifying data after registering the second scan data with the model; and

17[k] output, to the display, the model of the patient's teeth with the portion of the removed surface portion replaced using the received second scan data.

33. I understand that dependent claims 2-8 depend from claim 1, claims 10-16 depend from claim 9, and claims 18-20 depend from claim 17.

B. Prosecution of the '936 Patent and Prior Board Proceeding

34. I understand that, during prosecution of the '936 patent, the Examiner acknowledged the differences between the claims of the '936 patent and the conventional approach described in the prior art. For example, I understand that the Examiner concluded that the prior art undermined any motivation to update a user-specified part of an initial scan with new scan data of a modified portion of the patient's intraoral cavity to form a composite model, as recited in the claims of the '936 patent.

35. In particular, I understand that the Examiner identified "the Kriveshko WIPO reference (WO2007084647)" as the closest prior art and concluded that the reference taught that, when new scan data was obtained, "generating an entirely new scan rather than generating a composite scan by using a second scan to update the changed region from the first." EX1002 ('936 Prosecution History), 374-75. I

understand that the Examiner found that the Kriveshko WIPO reference “describes an iterative approach to managing a preparation where ‘a dentist may repeat steps of tooth removal and scanning until a satisfactory surface preparation is achieved,’” but he concluded that reference “involves complete rescans” and “teaches away from the claimed process, which data is newly captured and composited to update for the intra-oral modification.” *Id.*

36. I am further informed that, during prosecution of a related patent (US 16/176,474 (“the ’474 application)), the Examiner rejected claims that did not recite compositing new scan data of a physically modified portion of the patient’s intraoral cavity into an earlier scan over Paley (US 2007/0172112 A1), Rubbert (US 2002/0006217 A1), and Kriveshko (US 2007/0236494 A1”). EX2014 (’474 Application History), 35, 75. After amending the claims to require this feature, the Examiner allowed the claims, noting that “the feature of composite scan updates following modification to the dentition, e.g. after a removal operation was done on a tooth, [is] distinct from the noise/error correction rescans” disclosed by these references. *Id.*, 9, 12. I understand that these same reasons for allowance formed the Examiner’s basis for allowing the claims of the ’936 patent. *See id.*, 6-7; EX1002 (’936 Prosecution History), 374-75.

37. I am further informed that the ’936 patent was also the subject of a previous *inter partes* review brought by petitioner 3Shape A/S (“3Shape”). *See*

3Shape A/S v. Align Tech., Inc., IPR2021-01241, Paper 16 (PTAB an. 26, 2022). I am informed that, in this proceeding, the Board declined to institute trial. *Id.* In its decision not to institute trial, I understand that the Board acknowledged the Examiner’s findings made during prosecution of the ’936 patent. In particular, the Board stated:

The Examiner stated that the claims distinguish over the cited art by reciting “updating scans to be directed to scenarios where the intra-oral cavity (e.g. dentition) is modified in between the scans (e.g. subjected to surface preparation).” According to the Examiner, the cited art “does not provide for (or suggest) generating a composite scan after intra-oral modifications are made.” When distinguishing the cited art, the Examiner stated that “the instant applications’ claims ... provide a composite scan based on both a first (initial) and second (post-change) scan.” The Examiner characterized the claimed process as follows: “generating a composite scan by using a second scan to update the changed region from the first” and “data is newly captured and composited to update for the intra-oral modification.”

Id., 11.

38. I also understand that, in addressing 3Shape’s prior-art challenges, the Board found that the prior art failed to teach or suggest the claims of the ’936 patent and particularly focused on the limitations relating to generating a composite model to include scan data of a physically changed portion of the patient’s intraoral cavity. *See id.*, 15. I understand that the Board found that the

prior art failed to teach these limitations and also found that there was no “sufficient non-hindsight biased rationale” to modify the prior art to arrive at the invention claimed by the ’936 patent. *Id.*, 19.

39. As I explain more below, the prior art applied by Dr. Karam—in particular, Boerjes and Geng—are consistent with these prior findings by the Examiner and the Board. That is, both Boerjes and Geng teach the conventional approach of generating an entirely new scan rather than generating a composite scan by using a second scan of a physically modified portion of the patient’s intraoral cavity.

V. PERSON OF ORDINARY SKILL IN THE ART

40. I have been advised that a POSITA is a hypothetical person who is presumed to be familiar with all relevant art at the time of the invention, and to whom one could assign a routine task with reasonable confidence that the task would be successfully carried out. I understand that the relevant timeframe is July 19, 2010.

41. I understand that Dr. Karam contends that a POSITA, as of July 19, 2010, “would have been a person having at least a bachelor’s degree in electrical engineering, computer engineering, or a closely related field such as computer science, and two years of work experience in 3D imaging of physical structures, including the generation of 3D models of physical structures and image

processing.” EX1003 (Karam Declaration), ¶29. For the purposes of my declaration, I have applied this understanding of the POSITA in forming my opinions. By July 2010, I met and exceeded these qualifications. *See* EX2012 (Foroosh CV); *supra*, section I.

VI. CLAIM CONSTRUCTION

42. I have been advised that the claim terms of the '936 patent are to be given their plain and ordinary meaning, *i.e.*, the meaning that the terms would have to a POSITA at the time of the invention. I understand that the relevant timeframe is July 19, 2010.

43. I understand that this analysis focuses on intrinsic evidence, including how the claim term is used in the claims, specification, and prosecution history. I also understand that dictionaries or other extrinsic sources may assist in determining the plain and ordinary meaning but cannot override a meaning that is unambiguous from the intrinsic evidence. I have followed these principles in my analysis throughout this declaration.

44. In addition, Dr. Karam notes that the district court in the parallel proceeding involving Align and ClearCorrect provided the following preliminary claim constructions:

Claim Term	Court's Preliminary Construction
“replace [replacing] at least a portion of the [removed] surface portion of the model [...] using the received second scan data [at least a portion of the second scan data]” Ex-1001, cls. 1 (and dependent claims), 9 (and dependent claims), 17 (and dependent claims)	[register] / [registering] the [received] second scan data with a retained portion of the model after removing the scan data of the removed surface portion
“second scan data of the patient's teeth” Ex-1001, cl. 17 (and dependent claims)	Plain and Ordinary Meaning

See EX1003 (Karam Declaration), ¶34.

45. I understand that the district court has since adopted its preliminary constructions in a final claim construction order dated June 5, 2025. See EX2001, 10 (Claim Construction Order). For the purposes of my declaration, I apply the district court's constructions.

VII. GROUNDS 1-2: CLAIMS 1, 4-6, 8-12, AND 14-16 WOULD NOT HAVE BEEN OBVIOUS OVER BOERJES OR BOERJES AND GENG

46. I understand Dr. Karam contends that claims 1, 4-6, 8-12, and 14-16 would have been obvious over Boerjes (Ground 1) or Boerjes and Geng (Ground 2). In my opinion, however, claims 1, 4-6, 8-12, and 14-16 of the '936 patent would not have been obvious over Boerjes or Boerjes and Geng as proposed. In particular, it is my opinion that Dr. Karam fails to show that Boerjes and Geng

teach each and every limitation of the independent claims and fails to show that a POSITA would have been motivated to combine Boerjes and Geng as proposed.

A. Independent claim 1 is not obvious over Boerjes or Boerjes and Geng

47. As I detail more below, Dr. Karam's assertions that Boerjes (Ground 1) or Boerjes and Geng (Ground 2) render obvious independent claim 1 rests on the mischaracterization that Boerjes teaches selectively updating a user-identified portion of a 3D model after additional surface preparation of patient's intraoral cavity has been performed. Because Dr. Karam's analysis rests on this misreading of Boerjes, it is my opinion that Dr. Karam fails to show that Boerjes alone or Boerjes and Geng teach each and every limitation recited in the claims is found in the applied prior art, including limitations 1[e] and 1[h].

48. Moreover, I disagree with Dr. Karam that a POSITA would have been motivated to combine Boerjes and Geng in the manner proposed. Specifically, even if a POSITA would have sought to use Geng's editing and merger tools as part of Boerjes's system, a POSITA would have understood that Boerjes still teaches performing a rescan of a patient's intraoral cavity after additional surface preparation has been performed, which is consistent with the conventional approach known at the time, rather than replacing a portion of an original model to build a composite model as claimed by the '936 patent. In my opinion, neither Boerjes nor Geng provide reason for deviating from the conventional approach

taught in Boerjes. This conclusion is further supported by the fact that Geng itself suggests that the same, conventional approach be followed using its system, and does not suggest using its editor tool and merger tool in the manner that Dr. Karam proposes.

49. Accordingly, for the reasons discussed below, it is my opinion that Dr. Karam has failed to show independent claim 1 is obvious over Boerjes or Boerjes and Geng.

i.Dr. Karam fails to establish that Boerjes and Geng teach receiving user input defining a portion of the model to be removed (limitation 1[e])

50. Limitation 1[e] recites *receive user input defining a portion of the model to be removed*.¹ For both grounds, Dr. Karam asserts that Boerjes teaches a system that receives user input defining a portion of the model to be replaced with new scan data. See EX1003 (Karam Declaration), ¶88 (“Boerjes discloses a process in which the system receives user input defining a portion of the model to be replaced with new scan data following physical changes to the intraoral cavity.”). Based on this assertion, Dr. Karam contends that a POSITA “implementing Boerjes would have found it preferable and obvious to *remove* the

¹ I italicize language that appears in the challenged claims through this declaration.

user-identified surface portion from the model before *replacing* it with new scan data” (*id.*, ¶92) or would have been motivated to incorporate Geng’s editor tool to remove the user-identified portion on the model (*id.*, ¶¶101-102). As I explain below, it is my opinion that Boerjes does not describe that the user identifies a particular portion of a model to be replaced with new scan data.

51. Dr. Karam points to Boerjes’s quality control process (in particular, its manual quality control process, shown as step 408 in FIG. 4) as teaching receiving user input defining a portion of the model that needs to be replaced with new scan data. *See id.*, ¶ 88 (annotating step 408 as “Receive user input identifying a portion of the model to be removed/replaced”). However, while Dr. Karam cites to several paragraphs of Boerjes as supporting this conclusion, Boerjes’s disclosure is silent on this aspect.

52. For example, Dr. Karam relies on paragraphs 189 and 193 of Boerjes as describing instances where “a user may inspect the model and identify areas that need replacing, such as a ‘margin line’ to be removed, ‘areas of poor margin preparation,’ and ‘holes or areas of incomplete scan[s].’” *Id.*, ¶88 (alteration original). However, neither of these paragraphs supports Dr. Karam’s reading of Boerjes.

53. Paragraph 189 relates to the separate step (step 406) of Boerjes’s automated quality control process. EX1004 (Boerjes), [00189]. Boerjes explains

that the system may automatically perform analysis of the digital model, such as “simple quantitative analysis such as measures of accuracy, variability, or density of three-dimensional surface data for a digital model” or analysis of “adequacy and/or suitability of margins and prepared surfaces for an anticipated restoration.”

Id. This latter analysis can include examining “a prepared tooth surface to ensure that a margin line is present all the way around a preparation” or “the prepared surface to ensure that adequate material has been removed to accommodate a restoration.” *Id.*; *see also id.* (Boerjes explaining that the analysis also “may locate areas of potential problems, such as occlusal high spots, occlusal clearance, occlusal irregularities, areas of poor margin preparation, areas of inadequate tooth removal, improper taper, improper draw path or removal for a multiple unit preparation, inappropriate contour, and so forth”). Nothing in this paragraph indicates that the system accepts user input indicating portions of the 3D model that need replacing with new scan data.

54. Paragraph 193 also lacks such disclosure. Instead, the paragraph only states that the dentist may “visually” inspect a scan to “identify, e.g., holes or areas of incomplete scan needed for an intended dental procedure” and may employ “features, such as rotation, zooming, and panning” to perform the visual inspection. EX1004 (Boerjes), [00193].

55. Dr. Karam also points to Boerjes’s paragraph 196 as describing “a user ‘identif[ying] ... regions of a prepared tooth surface requiring additional preparation[s]’ and ‘supplemental scanning.’” EX1003 (Karam Declaration), ¶88 (alterations original). Dr. Karam then argues that because Boerjes provides “‘a number [of] interactive, three-dimensional tools such as markup tools’ that ‘a dentist or other dental professional’ could use to identify, during the quality control process, unsatisfactory areas, which could use supplemental scanning,” a POSITA “would have understood that the user would interact with the displayed model ... to indicate areas of the model to be replaced.” *Id.*, ¶89.

56. None of the paragraphs cited by Dr. Karam supports Dr. Karam’s conclusion regarding Boerjes. Paragraph 196 only describes that “[f]eedback may be presented to a dentist in a number of forms,” such as “highlighting questionable or erroneous areas of a preparation within a rendered display of scan data.” EX1004 (Boerjes), [00196]. This fails to state that the user delineates a portion of the 3D model that should be replaced with new scan data.

57. Similarly, Dr. Karam cites to paragraph 192, but this paragraph only describes that the system may include “markup tools” that a dentist may use “to evaluate suitability for subsequent processing and the creation of a physical dental object such as a restoration”—not to identify a portion of the model to be replaced by the system. *Id.*, [00192]; *see also id.*, [00142] (generally describing that the

computer may include a “display capable of receiving user input”), [00148] (stating the user “may define or specify a cementation void or die spacer” or “define, edit, or annotate a margin line, such as a computer-generated margin line”); EX1003 (Karam Declaration), ¶89 (citing same).

58. Dr. Karam also cites to paragraphs 197 and 199, but these similarly fail to describe that the system receives user input identifying a portion of the model to be replaced with new scan data. Paragraph 197 only states that the quality control steps of FIG. 4 “are not mutually exclusive,” but, as noted above, Boerjes does not state that, during any of its quality control steps, the system receives user input identifying a portion of the 3D model to be replaced. EX1004 (Boerjes), [00197]. Paragraph 199 (which I discuss in more detail below with respect to limitation 1[h]) only discusses two alternatives that may be performed after the quality control steps, supplementing the digital model “to replace apparently erroneous or inadequate scan data” or replacing the digital model with “a new scan of the dental subject matter following, e.g., additional surface preparation.” *Id.*, [00199]. Again, Boerjes is silent on the user identifying a portion of the model to be replaced with new scan data.

59. Dr. Karam’s additional contentions do not remedy these deficiencies. For instance, Dr. Karam argues that “[s]uch an identification of areas to be replaced also would have been obvious to a person of ordinary skill in the art in

view of the general capabilities well-known in the art to identify defective areas of a model and replace them using image registration.” EX1003 (Karam Declaration), ¶89. However, the relevance of this is unclear. Dr. Karam’s analysis is premised on the notion that Boerjes teaches replacing a portion of a model with new scan data following physical changes to the intraoral cavity. *Id.*, ¶88. This is distinct from systems aimed at “noise/error correction” in the 3D model itself, as recognized by the Examiner. *See* EX2014 (’474 Application History), 9.

60. Similar deficiencies exist with respect to Dr. Karam’s reliance on Geng. Dr. Karam asserts that a POSITA “would have been motivated, when implementing Boerjes’s replacement process, to use Geng’s editing function to remove the user-identified, undesirable portion from the model to improve the efficiency and accuracy of the replacement process.” EX1003 (Karam Declaration), ¶101. Thus, Dr. Karam’s combination of Boerjes and Geng assumes that Boerjes teaches a “replacement process,” with Geng’s editing tool being used to “remove” the portions on the model that have been identified by the user in Boerjes’s system. *Id.* However, as detailed above, Boerjes does not describe a “replacement process” in which a user identifies a portion of the 3D model to be replaced with new scan data.

61. Moreover, in my opinion, a POSITA would not have understood Geng as describing that its editing tool can be used by a user to remove a portion of a 3D

model to be updated with new scan data. Instead, a POSITA would have understood Geng describes that its editor tool serves a cleanup function, such as, noise removal and smoothing, of scan data. EX1005 (Geng), 7:38-51. This includes Geng’s description that its editor tool “allows operators to modify and/or eliminate any undesirable areas.” *Id.*, 7:40-44. When read in context, a POSITA would have understood that the “undesirable areas” referenced by Geng referred to scan data that the user did not need as part of the 3D model (*e.g.*, extraneous parts or unnecessary noise). *Id.* (“The editor (312) allows operators to modify and/or eliminate any undesirable area(s) on the original 3D image obtained from the camera (104; FIG. 1), remove abnormal data point(s), and clean up the acquired image data **to reduce the sizes of image data files.**” (emphasis added)). Thus, Geng also does not describe that its editing tool is used to remove a portion of a 3D model in order to be replaced with new scan data. As I describe further below, this deficiency in Geng raises additional issues regarding Dr. Karam’s proposed combination of Boerjes and Geng to replace the identified portion with post-modification scan data, as discussed more below with respect to limitation 1[h] and motivation to combine. *See infra*, section VII.A.ii-iii.

62. Thus, it is my opinion that Boerjes and Geng fail to teach limitation 1[e].

ii. Dr. Karam fails to establish that Boerjes and Geng teach replacing a portion of the model with second scan data of a physically changed portion of the patient's intraoral cavity (limitation 1[h])

63. Limitation 1[h] recites *replace at least a portion of the removed surface portion of the model using the received second scan data of the patient's teeth including surface data of a physically changed portion of the patient's intraoral cavity*. This limitation requires that a previously generated model ("the model") be updated by replacing a removed portion of the model with new scan data of the patient's mouth after a physical change has occurred ("surface data of a physically changed portion of the patient's intraoral cavity").

64. For Ground 1, Dr. Karam asserts that Boerjes teaches limitation 1[h]. See EX1003 (Karam Declaration), ¶¶109-117. However, I understand that, in its institution decision, the Board found that "the disclosure of Boerjes does not teach or suggest" the features claimed in limitation 1[h]. Inst. Dec., 19. As I detail more below, I agree with the Board's findings. In my opinion, Dr. Karam fails to show that Boerjes teaches *replac[ing] at least a portion of the removed surface portion of the model using the received second scan data of the patient's teeth including surface data of a physically changed portion of the patient's intraoral cavity*, as required by limitation 1[h].

65. For Ground 2, Dr. Karam further relies on Geng. See EX1003 (Karam Declaration), ¶¶118-123. In particular, Dr. Karam argues that a POSITA

would have been motivated to use Geng’s “merger tool” together with its “editor tool” to replace the removed portion of the model with scan data of a physically changed portion of the patient’s mouth. *See id.* However, Geng does not teach (and Dr. Karam does not assert that Geng does) *replac[ing] at least a portion of the removed surface portion of the model using the received second scan data of the patient’s teeth including surface data of a physically changed portion of the patient’s intraoral cavity*, as required by limitation 1[h]. In this regard, neither Boerjes nor Geng teaches the features of limitation 1[h].

a. Boerjes fails to teach limitation 1[h]

66. Dr. Karam contends that Boerjes teaches obtaining scan data of a *physically changed portion of the patient’s intraoral cavity* when Boerjes discusses modifying a portion of the patient’s mouth in areas that require “additional [surface] preparation or reduction” (*e.g.*, additional shaping of a prepared tooth surface). *See* EX1003 (Karam Declaration), ¶107 (addressing limitation 1[g], asserting Boerjes teaches that “a dentist can identify areas that require additional preparations, complete the preparations, and then rescan these areas”) (citing EX1004 (Boerjes), [00193], [00196], [00199]). Dr. Karam also contends that Boerjes teaches *replac[ing] at least a portion of the removed surface portion of the model using* scan data of the modified portion of the patient’s mouth to create a composite 3D model. *See id.*, ¶¶109-117. However, as I explained below, the

parts of Boerjes relied upon by Dr. Karam fail to disclose building a composite model from a first scan modified to include portions of a second scan following physical changes to the patient's intraoral cavity.

67. First, Dr. Karam identifies paragraph 199 of Boerjes as allegedly “disclos[ing] obtaining new scan data, i.e., second scan data, to ‘*replace[]*’ the portion identified by the user following additional surface preparations to correct deficiencies of the tooth preparation—i.e., after a portion of the patient's intraoral cavity has been ‘physically changed.’” *Id.*, ¶109 (citing EX1004 (Boerjes), [00196], [00199]). However, I disagree that paragraph 199 discloses building a composite model from two different scans in which one scan includes a modified portion of the patient's mouth.

68. Paragraph 199 of Boerjes states:

After one or more quality control steps 406-410, a determination may be made as to whether a scan and/or surface preparations are satisfactory. If the data is not satisfactory, the process 400 may proceed to step 414 where the digital model may be supplemented or replaced with new scan data. This may include, for example, new scanning to replace apparently erroneous or inadequate scan data, or a new scan of the dental subject matter following, e.g., additional surface preparation consistent with errors identified during quality control. The process 400 may then return to step 404 where a new digital model is obtained.

EX1004 (Boerjes), [00199].

69. As shown above, Boerjes describes that two alternatives may occur for step 414 after quality control has been performed. First, the digital model may be “supplemented,” and second, the digital model may be “replaced.” Paralleling these two options, Boerjes then goes on to describe how each may be performed, in order, disclosing that this can include (1) new scanning to replace apparently erroneous or inadequate scan data, or (2) a new scan of the dental subject matter following, e.g., additional surface preparation. As paragraph 199 makes clear, the only option Boerjes provides following “additional surface preparation” is an entirely new scan of the dental subject matter.

70. This is evident from Boerjes itself. In particular, Boerjes states that if “a scan and/or surface preparations” are determined not to be satisfactory, the process proceeds to step 414, “where the digital model may be supplemented or replaced with new scan data,” which may include “new scanning to replace apparently erroneous or inadequate scan data, or **a new scan of the dental subject matter following, e.g., additional surface preparation** consistent with errors identified during quality control.” *Id.*, [00199] (emphasis added). A POSITA would have understood from this description that Boerjes is teaching the conventional approach known at the time—*i.e.*, that **a new scan of the dental subject matter** is obtained following physical modification of the surface

preparation. See EX1001 ('936 patent), 2:17-22 (“Such situations would conventionally require a rescanning of the entire physical item....”); EX1002 ('936 Prosecution History), 374-75 (Examiner noting the prior art teaches “generating an entirely new scan rather than generating a composite scan”).

71. To the extent Dr. Karam attempts to conflate Boerjes’s separate discussion of new scanning to “replace” scan data with Boerjes’s discussion of additional surface preparation, this mischaracterizes Boerjes. Boerjes does not mention “replac[ing]” scan data in connection with additional surface preparation. Instead, Boerjes discusses the replacement operation in connection with **erroneous or inadequate scan data**, which is distinct from performing new scanning subsequent to a physical change to the patient’s intraoral cavity. By contrast, after “additional surface preparation” has been performed, Boerjes explicitly calls for an entirely “new scan of the dental subject matter”—Boerjes does not state that it is replacing a region or compositing with a prior scan.

72. Other paragraphs that Dr. Karam cites also fail to support that Boerjes teaches replacing a portion of a model with second scan data following physical changes to the patient’s intraoral cavity. For example, Dr. Karam also cites to paragraph 196 of Boerjes. See EX1003 (Karam Declaration), ¶109. However, this paragraph confirms that Boerjes distinguishes between supplemental scanning of

the same unmodified dental structure due to incomplete data and, distinctly, obtaining an entirely new scan following additional surface preparation.

73. More specifically, paragraph 196 states that “an evaluation may conclude with an identification of regions of a prepared tooth surface requiring additional preparation or reduction, **or** regions of a digital model requiring additional or supplemental scanning due to incomplete, erroneous, or potentially erroneous data.” EX1004 (Boerjes), [00196] (emphasis added). Again, Boerjes associates “regions of a digital model requiring additional or supplemental scanning” with “incomplete, erroneous, or potentially erroneous data,” as opposed to “regions of a prepared tooth surface requiring additional preparation or reduction.” *Id.* As I detailed above, where there is “additional surface preparation,” Boerjes states that a new scan should be taken. *Id.*, [00199]. Like paragraph 199, paragraph 196 provides no discussion of constructing a composite digital model from different scans with different surface preparations.

74. The remaining paragraphs that Dr. Karam cites also fail to support that Boerjes teaches limitation 1[h]. In contending that Boerjes teaches that, in its “manual quality control process, the dentist identifies areas that require additional preparations, completes the required preparations, and then rescans these areas,” Dr. Karam cites to Boerjes’s paragraph 193. EX1003 (Karam Declaration), ¶107. However, in paragraph 193, Boerjes merely describes that the manual quality

control step (step 408 of FIG. 4) involves the dentist inspecting a scan “to visually identify, e.g., holes or areas of incomplete scan needed for an intended dental procedure,” which says nothing about partial rescanning subsequent to additional surface preparation and building a composite model from an earlier scan and a new scan post-modification. EX1004 (Boerjes), [00193].

75. Moreover, paragraphs 197 and 198 of Boerjes (which Dr. Karam cites in paragraph 110 of her declaration) similar lack any such disclosure. These paragraphs only state that different quality control steps are not mutually exclusive and can be performed during a single visit. EX1004 (Boerjes), [00197]-[00198].

76. Similarly, paragraph 139 of Boerjes (which is cited in paragraph 125 of Dr. Karam’s declaration) explains that the 3D model can be of “some or all of the dentition according to [the] particular purpose of the scan.” EX1004 (Boerjes), [00139]. This portion of Boerjes just states that the model can be of some or all of the patient’s teeth. There is no discussion of amalgamating different pre- and post-physical modification scans to build a composite model. This also applies to Dr. Karam’s citation to paragraphs 189 through 199, which generally relate to Boerjes’s quality control steps. See EX1003 (Karam Declaration), ¶109. These paragraphs still fail to describe the claimed requirement of rescanning a **part** of a patient’s intraoral cavity **after physical modification** to replace **part** of a prior model.

77. Dr. Karam also cites to paragraph 163 of Boerjes, asserting that it teaches that a “scan may be obtained of a prepared surface” followed by “combining historical three-dimensional data with a three-dimensional representation of the prepared surface.” *Id.*, ¶110. I disagree. In this paragraph, Boerjes is discussing fabrication of a “restoration” based on multiple representations. Boerjes does not propose combining these data **into a new composite model**. EX1004 (Boerjes), [00163]. That is, a POSITA would have understood that Boerjes is describing the use of both a historical model and a new (post-preparation) model **of the entire dental subject matter** to fabricate a temporary or final restoration, not combining them to make some new composite dental model.

78. Indeed, that Boerjes is discussing separate models representing the entire dental subject matter for the restoration is confirmed in paragraph 32. Specifically, Boerjes states that “an electronic dental prescription” for fabricating an artificial dental object includes “a first three-dimensional representation of one or more intraoral structures including at least one tooth surface prepared for an artificial dental object” (*i.e.*, a post-preparation model) and “a second three-dimensional representation of the at least one tooth surface prior to preparation for the artificial dental object” (*i.e.*, a historical model). EX1004 (Boerjes), [0032].

79. I also disagree with Dr. Karam’s annotations of FIG. 4 of Boerjes. Specifically, as shown below, Dr. Karam adds an annotation to Boerjes’s step 414 that states “Receive second scan data including surface data of physically changed portion,” which is followed by step 404, annotated as “Replace user-identified portion of the model using second scan data to obtain an updated model.”

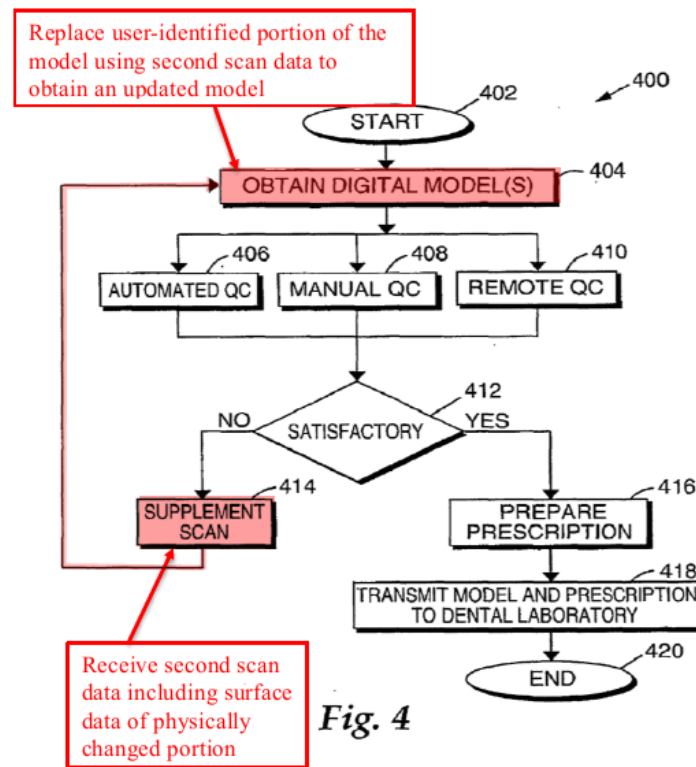


Fig. 4

EX1003 (Karam Declaration), ¶110.

80. In my opinion, these annotations are not supported by Boerjes and, in fact, do not match how Boerjes describes its quality control steps. For example, Boerjes states that in “step 414 ... the digital model may be supplemented or replaced with new scan data,” which can either be “new scanning to replace

apparently erroneous or inadequate scan data, **or a new scan of the dental subject matter following, e.g., additional surface preparation.**” EX1004 (Boerjes), [00199]. This is followed by “step 404 where a new digital model is obtained.” *Id.* Thus, in detailing the steps of FIG. 4, Boerjes describes generating a new digital model based on an entirely new scan when the patient’s intraoral cavity is altered, such as by performing additional surface preparation, not receiving “second scan data” of a modified region and replacing a part of the model with the second scan data as Dr. Karam asserts via annotations.

81. Dr. Karam also argues that a POSITA would have been motivated to use “well-known image registration and stitching techniques as in Boerjes” to “replace at least a portion of the model with the new scan data.” EX1003 (Karam Declaration), ¶112. However, Dr. Karam’s argument is conclusory because it fails to show how the teachings of Boerjes together with such “image registration and stitching techniques” would result in building a composite model by replacing a portion of an old scan with a later scan of dentition that was physically changed. As I explained above, Boerjes describes two separate scenarios: (1) supplementing inadequate scan data and (2) generating an entirely new scan following additional preparation, neither of which discloses the features recited in limitation 1[h].

82. In addition, to support her assertion, Dr. Karam argues “Boerjes discloses registering and combining or stitching 3D data into an aggregate 3D

model.” *Id.* (citing EX1004, [00126], [00144], [00218]). However, each of the cited portions describe image acquisition and construction **during** a scanning operation. See EX1004, [00126] (“forming a three-dimensional view of a subject reconstructed from a number of two-dimensional views.”), [00144] (“two dimensional image sets may be forwarded to the computer 108 for derivation of three-dimensional point clouds”), [00218] (“in a system that operates to continuously acquire three-dimensional data in real time, and fits or registers incremental three-dimensional data to an aggregate three-dimensional model...”). There is no disclosure of building a composite model by amalgamating portions of a new scan following physical modification together with an old, pre-modification scan.

83. Dr. Karam also generally refers to “Section V.C” for the notion that “both image registration and stitching were commonly known and used in computer vision and image processing applications.” EX1003 (Karam Declaration), ¶112. However, the general assertion that stitching data during image acquisition was generally known does not speak to building a composite model by replacing a portion of an old scan with a later scan of dentition that was physically changed. As I noted above, Boerjes fails to teach or suggest making a new model by adding post-modification scan-data to replace corresponding parts of a prior model, thereby producing a new model that is a composite of the pre-

and post-modification scans. In other words, that registering and stitching were known methods is beside the point because Boerjes informs the POSITA what to do in instances where additional surface preparation is required: take “a new scan of the dental subject matter.” EX1004 (Boerjes), [00199].

84. I understand that in the institution decision, the Board agreed that Boerjes only “contemplates the re-scanning of the dentation” after additional surface preparation and “does not assert partial insertion of new data into an existing 3D model.” Inst. Dec., 18-19. For the reasons discussed above, I agree with the Board’s conclusions.

85. Moreover, additional aspects of Boerjes further support the Board’s reading of Boerjes. For example, in paragraphs 36-37, Boerjes explains that, after acquiring a three-dimensional representation of an intraoral structure in which “one tooth surface [is] prepared for an artificial dental object,” feedback may be provided to the dentist, which “may identify corrective action.” EX1004 (Boerjes), [0036]-[0037]. Boerjes explains that “[t]he corrective action may include acquiring **an additional** three-dimensional representation” of the intraoral structure and “may include additional surface preparation of the at least one tooth.” *Id.*, [0037] (emphasis added). This is consistent with Boerjes’s paragraph 199 teaching that “a new scan of the dental subject matter” (or “an additional three-dimensional representation”) is taken after additional surface preparation.

86. In addition, Dr. Karam's cross-examination testimony further illustrates that she is mischaracterizing the plain teachings of Boerjes. For example, Dr. Karam argued that because Boerjes's FIG. 4 labels step 414 as "supplemental scan," then this means that "you are supplementing, doing a second supplement model for that region ... that is being sent back and this is being incorporated in the first model to form a new updated model." EX2013 (Karam Depo. Tr.), 61:24-62:6; *see also id.*, 74:10-75:7. However, in my opinion, this reading of Boerjes's FIG. 4 in this manner necessarily **excludes** Boerjes's express description of this step, especially as it relates to instances where "additional surface preparation" are required. In these instances, Boerjes clearly states that **the digital model** may be **replaced** with "a new scan of the dental subject matter." EX1004 (Boerjes), [00199].

87. Moreover, Dr. Karam also argued that when Boerjes discusses that quality control may include "visually confirm[ing] accuracy of a scan by inspection for gross errors or omissions such as holes, gaps, distortions, twists, and the like," this contemplates identifying whether a tooth preparation is adequate. EX2013 (Karam Depo. Tr.), 88:5-90:25 (stating an inadequate surface preparation of **the tooth** means that the **scan** is inaccurate and contains gross errors). Dr. Karam made similar assertions with respect to Boerjes's description of "erroneous data" as encompassing inadequate tooth preparations. *Id.*, 117:23-119:14.

88. Again, it is my opinion that Dr. Karam’s assertions are inconsistent with Boerjes’s plain description. Boerjes repeatedly distinguishes the “accuracy of a scan” and “erroneous” scan data from an assessment as to whether a tooth preparation is adequate. *See, e.g.*, EX1004 (Boerjes), [00195] (stating “a prepared tooth ... may be evaluated to determine whether there is adequate space for cement to bond the restoration to the prepared tooth surface” and, “[a]s another example, a dentist may visually confirm accuracy of a scan by inspection for gross errors or omissions such as holes, gaps, distortions, twists, and the like”), [00196] (evaluation may include “an identification of regions of a prepared tooth surface requiring additional preparation or reduction, or regions of a digital model requiring additional or supplemental scanning due to incomplete, erroneous, or potentially erroneous data”), [00199] (distinguishing between “erroneous or inadequate scan data” and “additional surface preparation”). By conflating the two (erroneous **scans** versus inadequate tooth preparations), which Boerjes treats as distinct concepts, Dr. Karam mischaracterizes Boerjes’s disclosure.

89. Thus, it is my opinion that Boerjes fails to teach limitation 1[h].

b. Boerjes and Geng fail to teach limitation 1[h]

90. For Ground 2, Dr. Karam adds Geng, arguing that a POSITA “would have been found it obvious to use Geng’s merger function to implement the replacement of the undesired portion in the model with the second scan data in

Boerjes.” EX1003 (Karam Declaration), ¶119. Specifically, Dr. Karam proposes using Geng’s merger tool (in conjunction with its editor tool) in Boerjes’s system to remove a portion of the model in which inadequate surface preparation has been identified (using Geng’s editor tool) and replace the portion with new scan data of the patient’s teeth after additional surface preparation to obtain a composite model. *See id.*, ¶¶100-101, 119-121.

91. However, as I explain below, while Geng provides general description of an editor tool and a merger tool as part of its system, Geng provides no disclosure of using these tools in the manner proposed—that is, using Geng’s editor tool to remove a portion of the model identified by the user to be replaced and then using Geng’s merger tool to replace the removed portion with new scan data of a physically changed portion of the patient’s intraoral cavity. Thus, in my opinion, neither Boerjes nor Geng teach limitation 1[h] as recited in the claim.

92. As an initial matter, I note that, for limitation 1[h], Dr. Karam only relies on **incorporating** Geng’s merger tool to accomplish Boerjes’s alleged functionality of replacing a removed portion of the model with a physically changed portion obtained from a subsequent scan. *See* EX1003 (Karam Declaration), ¶121 (asserting “in Boerjes’s system combined with Geng’s teachings, the second scan data would be registered to a retained portion of the existing model that has the user-identified portion removed, to replace this

removed portion with the new scan data, thereby obtaining an updated digital model of the teeth, e.g., **after additional surface preparation, as disclosed in Boerjes**” (emphasis added)). Thus, Dr. Karam does not assert that Geng itself teaches or suggests *replac[ing]* a portion of a model using scan data that *includ[es] surface data of a physically changed portion of the patient’s intraoral cavity.*

93. Indeed, I note that, during cross-examination, Dr. Karam was asked to identify the part of Geng that teaches “updating an existing digital impression after a physical change in the patient’s intraoral cavity.” EX2013 (Karam Depo. Tr.), 178:19-185:17. In response, Dr. Karam could only identify generic passages of Geng. *Id.* (citing EX1005, 3:48-4:2, 4:54-65, 6:26-41, 15:41-56).

94. However, these passages fail to describe replacing a portion of an existing model with scan data that includes a physically changed portion of the patient’s intraoral cavity. See EX1005, 3:48-4:2 (describing FIG. 1, which “is a block diagram illustrating a dental computer-aided design”), 4:54-65 (stating the computer “includes at least one access device and/or interface that allow operator to utilize the functionality of the computer”), 6:26-41 (describing the “GUI and file management module (220) and user access interface (224),” which “provide operators with interactive tools and views for manipulating 3D images”), 15:41-56 (stating, generally, that system allows “[f]abrication of prostheses may be

performed on-side, thereby allowing dental restoration procedures to be performed in a single visit”).

95. In addition, Geng describes its editor tool and merger tool separately. As I noted above, Geng describes its editor tool as a tool to clean up a scan (*e.g.*, removing noise or removing abnormal or extraneous data points). *Id.*, 7:38-51. Geng separately describes its merger tool as a tool that enables the generation of a 3D model in the first instance. *Id.*, 7:57-59. In fact, as I explain more below, rather than teaching the use of these tools as Dr. Karam proposes, Geng teaches following the conventional approach of initiating a new scan after additional surface preparation, consistent with Boerjes’s teachings.

96. Thus, it is my opinion that Boerjes and Geng fail to teach limitation 1[h].

iii.Dr. Karam fails to establish a motivation to combine Boerjes and Geng as proposed

97. In my opinion, Dr. Karam also fails to establish that a POSITA would have been motivated to combine Boerjes and Geng as proposed. As I noted above, Dr. Karam proposes incorporating Geng’s editor tool into Boerjes’s system as a means to remove a user-identified portion of an existing 3D model and further proposes incorporating Geng’s separate merger tool as a means to replace the removed portion with new scan data that includes a physically changed portion of

the patient's intraoral cavity. See EX1003 (Karam Declaration), ¶¶100-101, 119-121.

98. However, even if a POSITA would have incorporated Geng's editor tool and merger tool into Boerjes's system, the proposed combination still would not have resulted in the claimed invention because it rests on the incorrect assumption that Boerjes teaches replaced a removed portion of an existing model with scan data that includes a physically changed portion of the patient's intraoral cavity. That is, even if a POSITA would have been motivated to combine Boerjes and Geng as Dr. Karam proposes, the POSITA would have used those tools consistent with how Boerjes suggests: after additional surface preparation, "**a new scan of the dental subject matter**" is obtained—*i.e.*, the POSITA would have continued to follow the conventional approach known at the time. EX1004 (Boerjes), [00199].

99. I note that this understanding is further supported by Geng's own teachings. That is, like Boerjes, Geng's disclosure also comports with the conventional approach at the time that, when a physical structure in the patient's intraoral cavity has been modified, a new scan of that structure of that structure should be performed.

100. For instance, FIG. 5 of Geng illustrates "steps of dental restoration treatment preparations that utilize interactive 3D imaging." EX1005 (Geng), 2:53-

55. Geng explains that the process illustrated in FIG. 5 “can be implemented at the preparation appointment by utilizing the interactive 3D imaging functions provided by the system.” *Id.*, 10:64-11:2. Geng describes that, after an occlusal adjustment has been performed, “preliminary imaging of prepared teeth is utilized for treatment preparation.” *Id.*, 11:16-17, FIG. 5 (step 520). This preliminary imaging of prepared teeth “can be utilized for comparison with a predetermined baseline” to allow the dentist to “check certain factors that can help identify any potential issues that may affect the restoration process,” such as checking “alignment, margin design, tooth reduction, and retention and resistance form.” *Id.*, 11:25-31.

101. Geng teaches that, “[o]nce the preliminary imaging analysis has been completed,” and any necessary additional tooth preparation has been completed, “a final 3D image ... of the prepared teeth may be obtained at step (530) of FIG. 5.” *Id.*, 11:65-12:1. “This image provides the final image data upon which the restorations will be designed.” *Id.*, 12:1-2; *see also id.*, 12:2-7 (stating further that the final 3D image can be compared to the preliminary imaging to “confirm[] correction of any problems found in preliminary imaging”). Thus, like Boerjes, Geng also teaches obtaining a new scan after additional surface preparation, consistent with the conventional approach known at the time. Tellingly, Geng itself does not even suggest using **its own tools** in the manner suggested by Dr. Karam (*i.e.*, using the editor tool to remove a portion of the scan and then using the

merger tool to replace the removed portion with second scan data of the modified portion of the patient's mouth after additional surface preparation). Instead, Geng still follows the conventional approach. Therefore, Geng further undermines Dr. Karam's assertion that a POSITA would have been motivated to use Geng's editor and merger tools in Boerjes's system in the manner proposed.

102. Accordingly, in view of the above, it is my opinion that Dr. Karam fails to show that independent claim 1 is obvious over Boerjes or Boerjes and Geng.

B. Independent claim 9 is not obvious over Boerjes or Boerjes and Geng

103. In asserting that Boerjes (Ground 1) or Boerjes and Geng (Ground 2) render obvious claim 9, Dr. Karam refers to her analysis with respect to independent claim 1. See EX1003 (Karam Declaration), ¶150 (relying on analysis of limitation 1[h] for limitation 9[e]). Accordingly, for the same reasons I identified above with respect to claim 1, Dr. Karam fails to establish that independent claim 9 is obvious over Boerjes or Boerjes and Geng.

104. Furthermore, it is my opinion that Dr. Karam fails to show that Boerjes or Boerjes and Geng teach limitation 9[c]. Limitation 9[c] recites *receiving user input via the displayed model demarcating a portion of the model to be retained and a surface portion of the model to be replaced.*

105. Dr. Karam contends that “Boerjes discloses receiving user input identifying a portion of the displayed model to be replaced with new scan data.” EX1003 (Karam Declaration), ¶146. However, as explained above with respect to limitation 1[e], Boerjes provides no such disclosure and instead only generally discusses supplementing an existing 3D model (in the case of erroneous or inadequate scan data) or replacing it entirely (following additional surface preparation). See EX1004 (Boerjes), [00199]; *supra*, section VII.A.i. Thus, because Boerjes does not teach receiving user input identifying a portion of the model to be replaced, it also fails to teach receiving user input *demarcating a portion of the model to be retained and a surface portion of the model to be replaced*.

106. Dr. Karam contends that “it would have been obvious to a person of ordinary skill in the art to identify on the display a portion of the model to be retained as well as the portion to be replaced according to the user input.” EX1003 (Karam Declaration), ¶148. In support of this, Dr. Karam cites to EX1014 (Kopelman). *Id.* (citing EX1014, [0078], FIGS, 1, 4, 5); *see also id.*, ¶147. However, EX1014 does not describe demarcating a portion of a model to be retained and a portion of the model to be replaced with new scan data (thus preventing the new scan data from overwriting or otherwise impacting the surface of the retained portion). For example, EX1014 discusses identification of a

“demarcation profile” to separate a 3D virtual model into a first model part representing the dental site comprising a tooth preparation and a second model representing the soft tissues abutting the tooth preparation, with the user being able to “extrapolate where he or she considers” any finish line, gum line, or other preparation is present, but is missing in the model. See EX1014 (Kopelman), [0025], [0078], [0083], FIGS. 4-5.

107. Accordingly, for these additional reasons, it is my opinion that Dr. Karam fails to show that independent claim 9 is obvious over Boerjes or Boerjes and Geng.

C. Dependent claims 4-6, 8, 10-12, and 14-16 are not obvious over Boerjes or Boerjes and Geng

108. I understand claims 4-6, 8, 10-12, and 14-16 depend directly or indirectly from either claims 1 or 9. In my opinion, these claims are not obvious over Boerjes or Boerjes and Geng for the same reasons identified above with respect to the independent claims.

VIII. GROUNDS 3-4: CLAIMS 2-3, 7, 12, AND 17-20 WOULD NOT HAVE BEEN OBVIOUS IN VIEW OF BOERJES AND BABAYOFF OR BOERJES, GENG, AND BABAYOFF

109. In my opinion, Dr. Karam also fails to show that claims 2-3, 7, 12, and 17-20 are obvious over Boerjes and Babayoff (Ground 3) or Boerjes, Geng, and Babayoff (Ground 4).

110. As an initial matter, I note that claims 2-3, 7, and 13 depend from either independent claims 1 and 9. In addition, Dr. Karam relies on her analysis of claim 1 for independent claim 17, including relying on her analysis of limitations 1[e] and 1[h] as teaching limitation 17[f]-[17[g] and 17[i]. See EX1003 (Karam Declaration), ¶¶211-212, 214. Claims 18-20 depend from claim 17. As such, for the reasons I identified with respect to Grounds 1 and 2, Dr. Karam fails to establish that claims 2-3, 7, 13, and 17-20 are rendered obvious over Boerjes and Babayoff or Boerjes, Geng, and Babayoff.

111. In addition, as I explain below, Dr. Karam fails to establish the obviousness of these claims for additional reasons.

A. Dr. Karam fails to establish that a POSITA would have been motivated to combine Boerjes and Babayoff to add color scanning

112. For Grounds 3 and 4, Dr. Karam contends that a POSITA “would have been motivated to use Babayoff’s intraoral scanner in Boerjes’s system ... or Boerjes as modified by Geng.” *Id.*, ¶188. In particular, Dr. Karam asserts that a POSITA “would have understood that Babayoff’s color scan data or 3D color model would improve the dental restoration procedure of Boerjes or Boerjes as modified by Geng” because it “provides color data for presenting an accurate 3D color model.” *Id.*, ¶191. Dr. Karam also asserts that “Babayoff’s intraoral scanner with color scan data would improve Boerjes’s automatic identification of the margin line.” *Id.*, ¶192. Furthermore, Dr. Karam argues that a POSITA would

have had a reasonable expectation of success with the combination because Babayoff “provid[es] the benefit of precise color matching and additional ways to identify the margin line.” *Id.*, ¶194.

113. During cross-examination, I understand that Dr. Karam confirmed that the purported combination of Boerjes and Babayoff (or Boerjes, Geng, and Babayoff) relies on the assertion that Babayoff would improve Boerjes or Boerjes and Geng “by adding color scanning.” EX2013 (Karam Depo. Tr.), 37:3-39:24.

114. In my opinion, Dr. Karam fails to show that a POSITA would have understood that Babayoff’s scanner “would improve” Boerjes’s system (alone or as modified by Geng) because a POSITA would have recognized that Boerjes’s scanner system already captures color scan data for its 3D digital model. For example, Boerjes explains that “after completing a scan, a dental office may transmit a digital model to a dental laboratory or a fabrication facility for evaluation of adequacy of the scan,” where the dental laboratory may “evaluate color and suggest shade matching for a dentist.” EX1004 (Boerjes), [00194]. A POSITA would have understood this to mean that the digital model includes color data (so the dental laboratory can “evaluate color and suggest shade matching” based on its analysis of the digital model), and thus, Boerjes’s system already performs color scanning. In fact, I note that Dr. Karam agreed that the feedback

provided by the dental laboratory, including its evaluation of color, would be “based on the remote analysis of the digital model.” EX2013, 57:20-58:17.

115. Moreover, additional discussion in Boerjes confirms that a POSITA would have appreciated that Boerjes’s system already performs color scanning. For example, Boerjes describes using known tri-stimulus models (such as Hue-Saturation-Intensity models) that were known to provide color information for 3D color models. EX1004 (Boerjes), [00200] (teaching use of “a shade guide” such as “Vita 3D Master”). Boerjes also acknowledges that color is part of the prescription that specifies the type of restoration or other dental object needed for the scanned tooth preparation. *Id.*, [00181], FIG. 3; *see also id.*, [00194]. Because a POSITA would have understood that Boerjes’s system (including as modified by Geng) already performs color scanning, the POSITA would have appreciated that the benefits (*i.e.*, to “provide[] color data for presenting an accurate 3D color model” or “improve Boerjes’s automatic identification of the margin line”) identified by Dr. Karam can be achieved by Boerjes alone.

B. Dr. Karam fails to establish that Boerjes and Babayoff (Ground 3) or Boerjes, Geng, and Babayoff (Ground 4) Teach Claims 7, 13, and 17

116. As I explain below, it is also my opinion that Dr. Karam fails to show that dependent claims 7 and 13 and independent claim 17 are obvious over Boerjes and Babayoff or Boerjes, Geng, and Babayoff.

117. Claim 7 indirectly depends from claim 1 through claims 4-6. Claim 7 further recites *wherein the instructions to replace the at least the portion of the removed surface portion of the model using the received second scan data comprise instructions to further discard a remainder of the received second scan data, the remainder including the identifying surface data, after stitching the portion of the received second scan data with the model.* The claimed *identifying surface data* is recited in claim 5, where the identifying data is used to register the received second scan data with corresponding parts of the model. Thus, claim 7 claims the feature that, after the second scan data has been stitched to the portion of the model to be replaced, the portion of the second scan data used to register the scan data to the original model (*the identifying surface data*) is discarded. In other words, claim 7 specifies that the remainder of the second scan data that is not used for replacement is discarded (*e.g.*, so as not to overwrite or otherwise impact the portions of the model to be retained).

118. Dr. Karam argues that Boerjes in view of Babayoff or Boerjes in view of Geng and Babayoff renders this claim obvious. EX1003 (Karam Declaration), ¶197. In particular, Dr. Karam asserts that “Babayoff discloses discarding repeated data of overlapping areas after two or more data sets (digital models) are registered and stitched together.” *Id.*, ¶198 (citing EX1006 (Babayoff), [0176]-[0177]). Dr. Karam further argues that a POSITA “would have understood that in Boerjes or

Boerjes combined with Geng, stitching the second scan data to the existing model that has the user-identified portion removed would include identifying and aligning corresponding points or features (‘identifying surface data’/‘identifying data’) of the second scan data to corresponding parts of the retained portion of the model” and “the portion of the second scan data that includes the corresponding points or features” is *a remainder of the second scan data*. *Id.*, ¶200. Dr. Karam contends that a POSITA “would have been motivated to modify the system of Boerjes or Boerjes as modified by Geng to discard the corresponding points ... of the second scan data after registration and stitching, as taught in Babayoff,” because they “would be repetitive.” *Id.*, ¶201.

119. In my opinion, Dr. Karam fails to show that the applied references render claim 7 obvious. First, I note that Dr. Karam’s assertion still relies on the incorrect assumption that Boerjes teaches defining a portion of the model to be retained and a portion of the model to be replaced. *See supra*, sections VII.A.i, VII.B. Moreover, Dr. Karam cites to Boerjes as suggesting “aligning identifying data of the second scan data with corresponding parts of the model” based on its disclosure of stitching scan data to generate a 3D model. EX1003 (Karam Declaration), ¶130 (citing EX1004 (Boerjes), [00144]). Dr. Karam points to a similar stitching process for creating the 3D model in Geng. *Id.*, ¶132 (citing EX1005 (Geng), 7:57-8:3). However, neither reference describes that, during this

process, there is excess data or that excess data should be discarded. Thus, given that the references (1) fail to teach an identification of a portion of the model that should be retained and a portion that should be replaced, (2) fail to express a desire to discard scan data during the stitching process, Dr. Karam does not establish why a POSITA would have been motivated to turn to Babayoff in the first instance.

120. Moreover, even if a POSITA would have been motivated to modify Boerjes or Boerjes and Geng in view of Babayoff's teachings, it is my opinion that this would not result in *the remainder including the identifying surface data* being discarded. As I noted above, Dr. Karam argues that the claimed *identifying data* maps to the portions of the scan data used to align the data with corresponding parts of the model. See EX1003 (Karam Declaration), ¶200.

121. Babayoff teaches "discarding every data point that is repeated" after stitching. EX1006 (Babayoff), [0177]. However, the stitching processes described in the references would not discard the overlapping data set used to align the parts of the model because the overlapping data set would not be expected to be all repetitive. For example, Boerjes and Geng describe stitching data to existing three-dimensional data through optimization techniques. In other words, the system optimizes the alignment of data sets by fitting features of the data to be as close as possible. See EX1004 (Boerjes), [00144] (stating "[t]he three-dimensional data for each newly acquired two-dimensional image set may be derived and fitted

or ‘stitched’ to existing three-dimensional data”); EX1005 (Geng), 7:57-8:3 (“The merger (320) is able to bring the 3D images together and optimize the geometric registration of these images.”).

122. A POSITA would not have understood that the data used to align scan data with another data set would result in a one-to-one correspondence with each other. This is evident from Babayoff itself, in which “the overlap zones” of two data sets are numerically transformed (*e.g.*, by a series of translations and rotations) “until at least a portion of the data from the first entity coincides with at least a portion of the data from another entity.” EX1006 (Babayoff), [0177]. These coinciding portions are then “combined by adding both sets of coordinates, and discarding every data point that is repeated.” *Id.* In other words, Babayoff illustrates that the data used to align scan data with a corresponding part of a model can include data that is not a repeated point.

123. In view of this, a POSITA would have understood that, even if the teachings of Babayoff were followed (*i.e.*, discarding those points that are “repeated”), this would still not result in *the remainder including the identifying surface data* being discarded. This is because other data points that form the identifying surface data used to align the data sets (through, *e.g.*, best fit or common geometric features) would not be repetitive. This would be especially true in the combination proposed by Dr. Karam, where second scan data

representing a portion of the patient's mouth post-modification is being stitched together with a model representing the patient's mouth pre-modification. In such scenarios, it would be highly unlikely that the identifying data used to align the second scan data with the model would be repetitive of points in the original model, resulting in the identifying data being **retained** rather than discarded, as Babayoff teaches.

124. Accordingly, for the reasons above, it is my opinion that Dr. Karam fails to show that claim 7 is obvious over Boerjes and Babayoff or Boerjes, Geng, and Babayoff.

125. Dr. Karam incorporates her claim 7 analysis for dependent claim 13 and limitation 17[j] of independent claim 17. EX1003 (Karam Declaration), ¶¶204, 215. Accordingly, for the same reasons I identified above with respect to claim 7, Dr. Karam fails to show that claims 13 and 17 are obvious over Boerjes and Babayoff or Boerjes, Geng, and Babayoff.

IX. CONCLUDING STATEMENTS

126. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

127. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: 2/12/2026

By: /Hassan Foroosh/

Hassan Foroosh, Ph.D.

X. LIST OF MATERIALS CITED

Exhibit No	Description
	<i>ClearCorrect Operating, LLC v. Align Tech. Inc.</i> , IPR2025-00817, Paper 16 (P.T.A.B. Oct. 30, 2025) (Board's Decision on Institution)
1001	U.S. Patent No. 10,791,936 to Kopelman
1002	Prosecution History of U.S. Patent No. 10,791,936
1003	Declaration of Dr. Karam
1004	International Application Publication No. WO 2007/084727 A1 to Boerjes et al.
1005	U.S. Patent No. 7,474,932 B2 to Geng
1006	U.S. Patent Application No. US 2005/0283065 A1 to Babayoff
1014	U.S. Patent Application Publication No. US 2007/0015111 A1 to Kopelman et al.
2001	Claim Construction Order, <i>Align Technology Inc. v. ClearCorrect Operating LLC, et al.</i> , No. 24-cv-00187-ADADTG (W.D. Tex. Jun. 5, 2025)
2013	Transcript of the Deposition of Dr. Lina Karam, held on February 2, 2026
2014	Excerpts from Prosecution History of U.S. Application No. 16/176,474