

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ELECTRONIC ARTS INC. and EA DIGITAL ILLUSIONS CE AB,  
Petitioner,

v.

TERMINAL REALITY, INC.,  
Patent Owner.

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Cases IPR2016-00929 and  
IPR2016-00930  
Patent 7,061,488 B2

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Before BRYAN F. MOORE, BARBARA A. PARVIS, and  
DANIEL N. FISHMAN, *Administrative Patent Judges*.

PARVIS, *Administrative Patent Judge*.

FINAL WRITTEN DECISION  
35 U.S.C. § 318(a)

I. INTRODUCTION

A. *Background*

Electronic Arts Inc. and EA Digital Illusions CE AB (collectively  
“Petitioner”) filed two Petitions including a Petition in IPR2016-00929

(Paper 1, “Pet.”) and a Petition in IPR2016-00930 (Paper 1, “’930 Pet.”).<sup>1</sup> Petitioner requests that we institute *inter partes* review of claims 1–20 and 27–62 (“challenged claims”) of U.S. Patent No. 7,061,488 B2 (Ex. 1001, “the ’488 patent”). Terminal Reality, Inc. and Infernal Technology LLC (collectively or individually “Patent Owner”)<sup>2</sup> filed Preliminary Responses (Paper 6, “Prelim. Resp.”; Paper 6, “’930 Prelim. Resp.”). On October 25, 2016, we instituted an *inter partes* review of the challenged claims. Paper 7 (“Dec. on Inst.”). Because the subject matter of the claims and the challenges significantly overlap, we also consolidated the IPR2016-00929 and IPR2016-00930 *inter partes* reviews. *Id.* at 2.

After institution, Patent Owner filed a Patent Owner Response (Paper 21, “PO Resp.”), and Petitioner filed a Reply (Paper 32, “Reply”). A consolidated oral hearing for this consolidated case and related Case IPR2016-00928 was held July 18, 2017, and a transcript of the hearing has been entered into the record of the proceeding as Paper 49 (“Tr.”). We

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<sup>1</sup> Unless otherwise noted, citations are to the Petition and other documents filed in IPR2016-00929.

<sup>2</sup> Although Infernal Technology, LLC identifies Terminal Reality, Inc. as the owner of the ’488 patent, Infernal Technology, LLC asserts that it is the exclusive licensee of all substantial interests in the ’488 patent and has sole control over these proceedings. Paper 5, 1. Neither Petitioner nor Terminal Reality, Inc. challenge Infernal Technology, LLC’s assertions regarding its interests in the ’488 patent and right to control these proceedings. For the purposes of this Decision, we refer to Terminal Reality, Inc. and Infernal Technology collectively or individually as “Patent Owner.”

authorized Patent Owner to file a motion to strike Petitioner's Reply (Paper 40,<sup>3</sup> "Mot. Strike"), which Petitioner opposed (Paper 43, "Pet. Opp.").

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has not shown by a preponderance of evidence that claims 1–20 and 27–62 are unpatentable.

*B. Related Proceedings*

The parties state that the '488 patent is the subject of *Infernal Technology, LLC v. Electronic Arts, Inc.*, No. 2:15-cv-01523 (E.D. Tex.). Pet. 1; Paper 5 (Patent Owner's Mandatory Notices), 1. Petitioner also has filed IPR2016-00928, which requests *inter partes* review of another patent owned by Patent Owner. *Id.*

*C. Prior Art Relied Upon*

In support of its Petitions, Petitioner proffers the following prior art references:

Mark Segal, et al., *Fast Shadows and Lighting Effects Using Texture Mapping*, COMPUTER GRAPHICS PROCEEDINGS VOL. 26, No. 2, pp. 249–52 (July 1992) ("Segal," Ex. 1003).

Tom McReynolds, *Programming with OpenGL: Advanced Rendering*, (SIGGRAPH '96 Course, 1996) ("McReynolds," Ex. 1004).

James D. Foley, et al., *COMPUTER GRAPHICS PRINCIPLES AND PRACTICE*, 2d ed. (1997) ("Foley," Ex. 1007).

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<sup>3</sup> Patent Owner filed a Motion to Strike (Paper 38) and, as authorized via e-mail, a Corrected Motion to Strike (Paper 40). We refer to Patent Owner's Corrected Motion to Strike herein, unless otherwise noted.

*D. Instituted Grounds of Unpatentability*

We instituted on the following grounds of unpatentability:

| Challenged Claims | Basis | Reference(s)                 |
|-------------------|-------|------------------------------|
| 1–10 and 27–62    | § 103 | Segal                        |
| 1–10 and 27–62    | § 103 | Segal and Foley              |
| 1–20 and 27–36    | § 103 | Segal and McReynolds         |
| 1–20 and 27–36    | § 103 | Segal, McReynolds, and Foley |

In the Petition, Petitioner relies upon the Declaration testimony of Mr. Richard Goodin for support. Ex. 1005; Ex. 1105.<sup>4</sup> Patent Owner relies upon the Declaration testimony of Mr. Leonard Laub. Ex. 2008. In its Reply, Petitioner relies upon Reply Declaration of Mr. Goodin. Ex. 1023.

*E. The '488 patent*

The '488 patent is directed to methods for rendering lighting and shadows in computer graphic simulations. Ex. 1001, 1:10–14. Figure 2 of the '488 patent is reproduced below.

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<sup>4</sup> Petitioner's Declaration in IPR2016-00930 (Exhibit 1105) is substantially the same as its Declaration in IPR2016-00929 (Exhibit 1005), and any differences pertain to differences in the claim recitations and do not impact the analysis herein. *Compare* Ex. 1105, *with* Ex. 1005.

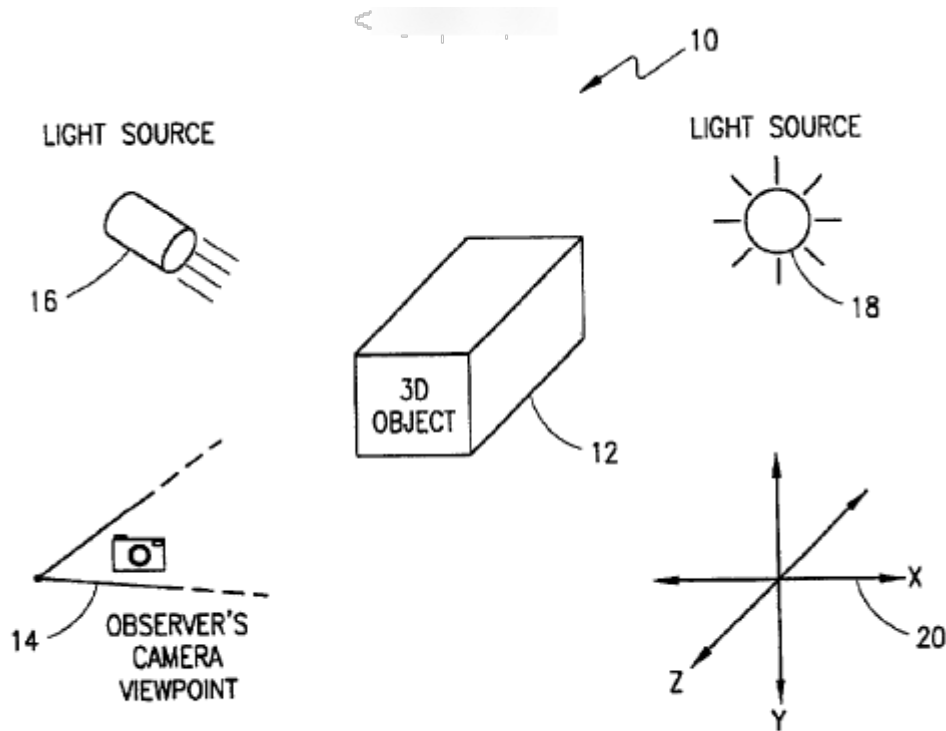


**FIG. 2**

Figure 2 illustrates a block diagram depicting a three-dimensional graphics scene.

Scene 10 depicted in Figure 2, above, includes at least one three-dimensional (3D) object 12, which is viewed from camera perspective 14. *Id.* at 6:30–32. Scene 10 is illuminated by first light source 16 and second light source 18. *Id.* at 6:40–42. World space coordinate system 20 is employed to define the 3D object 12, light source 16, and light source 18. *Id.* at 6:51–55.

Figure 4 of the '488 patent describes a process implemented in computer system 40 to render lighting and shadows for scene 10. *Id.* at 8:37–42. Figure 4 is reproduced below.

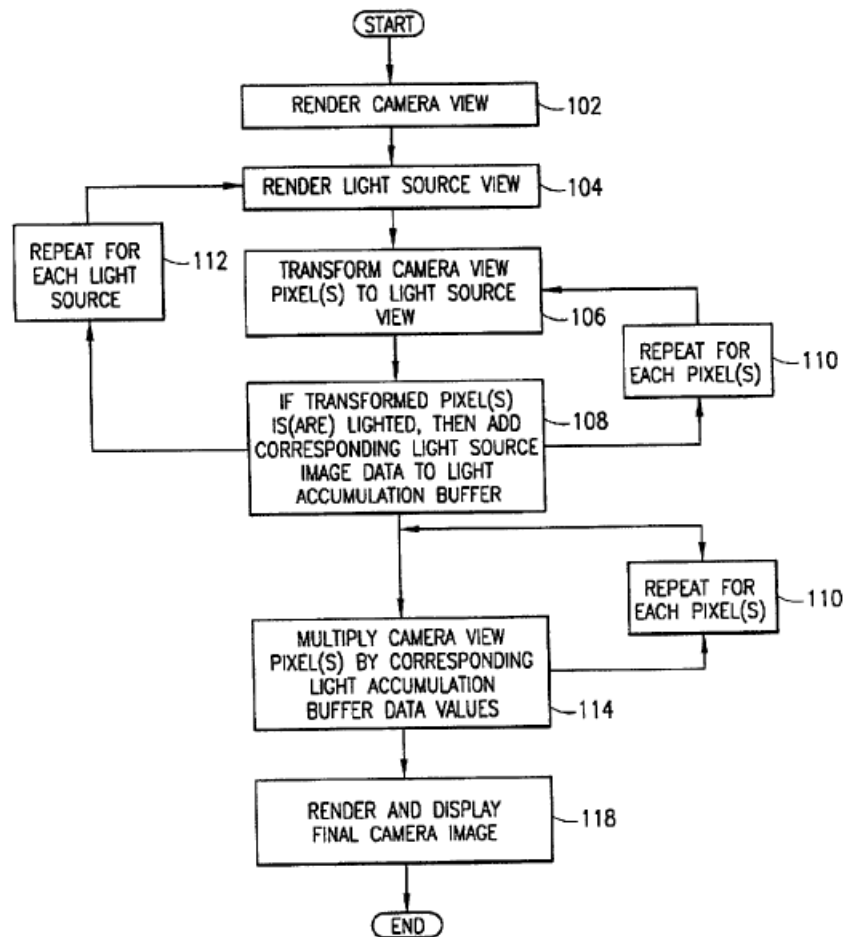


**FIG. 4**

Figure 4 illustrates a flowchart depicting a shadow rendering process for use in a computer system.

As illustrated above in Figure 4, process 100 begins by rendering the camera's view using "conventional methods," producing camera image 51A and camera depth 51B. *Id.* at 8:42–44. The light source view from one of the light sources is rendered in step 104. *Id.* at 8:44–46. In step 106, pixel 60 in camera image 51A is transformed using transformation calculations. *Id.* at 8:48–59. In step 108, if transformed pixel 60' is illuminated, then the corresponding pixel data value in the light image is added to light

accumulation buffer 51G. *Id.* at 8:60–63. As shown in step 110, steps 106 and 108 are repeated for each pixel in camera image 51A. *Id.* at 9:4–6. After all pixels in camera image 51A have been processed, the process is repeated for each additional light source, as reflected in step 112. *Id.* at 9:6–8. Then in step 114, a pixel data value from the camera image is multiplied by a corresponding pixel data value from light accumulation buffer 51G and the results are stored. *Id.* at 9:16–20. As shown in step 116, step 114 is repeated for each pixel in the camera image. *Id.* at 9:21–22. In step 118, the resulting camera image is rendered and displayed. *Id.* at 9:22–25.

*F. Illustrative Claim*

Claims 1, 11, 27, 37, and 50 are the independent claims challenged in this proceeding. Claims 2–10, 12–20, 28–36, 38–49, and 51–62 depend, directly or indirectly, from one of claims 1, 11, 27, 37, or 50. Independent claim 1 is illustrative of the claimed subject matter and is reproduced below:

1. A shadow rendering method, the method comprising the steps of:  
providing observer data of a simulated multi-dimensional scene;  
providing lighting data associated with a plurality of simulated light sources arranged to illuminate said scene, said lighting data including light image data;  
for each of said plurality of light sources, comparing at least a portion of said observer data with at least a portion of said lighting data to determine if a modeled point within said scene is illuminated by said light source and storing at least a portion of said light image data associated with said point and said light source in a light accumulation buffer;  
and then  
combining at least a portion of said light accumulation buffer with said observer data; and  
outputting resulting image data.

Ex. 1001, 12:8–25.

## II. CLAIM CONSTRUCTION

### A. *Legal Standard*

In an *inter partes* review, claim terms in an unexpired patent are interpreted according to their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cf. Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–45 (2016) (upholding the use of the broadest reasonable interpretation standard as the claim construction standard to be applied in an *inter partes* review proceeding). Consistent with the rule of broadest reasonable interpretation, claim terms are generally given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

### B. *The Parties’ Contentions*

In our Decision on Institution, we provided guidance on the broadest reasonable interpretations of the phrases: “at least a portion of said observer data” and “light accumulation buffer.” Dec. on Inst. 8–15. In particular, we determined that the broadest reasonable interpretation, in light of the specification, of the term “at least a portion of said observer data” encompasses observer data that have been transformed, such as observer depth data that have been transformed to light source view, as described in the ’488 patent Specification. *Id.* at 11. Additionally, we determined that the broadest reasonable interpretation, in light of the Specification, of the term “light accumulation buffer” is “a buffer for accumulating light falling on a pixel.” *Id.* at 15. Furthermore, we provided guidance regarding claim dependency errors introduced during prosecution. *Id.* at 15–17.

Subsequent to our Decision on Institution, both parties provide contentions regarding the broadest reasonable interpretations for the terms: “light accumulation buffer” and “precalculated matrix transformation look-up table.” PO Resp. 6–10; Reply 2–4. For purposes of this Final Written Decision, and based on the full record before us, no further express construction of any claim term is required. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (only those terms which are in controversy need to be construed and only to the extent necessary to resolve the controversy)

### III. ANALYSIS

#### A. *Principles of Law*

To prevail in its challenges to the patentability of the claims, a petitioner must establish facts supporting its challenges by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). The question of obviousness, under 35 U.S.C. § 103(a), is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). In that regard, an obviousness analysis “can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007).

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed.

Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden never shifts to Patent Owner. See *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in *inter partes* review). Furthermore, Petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

Thus, to prevail in an *inter partes* review, Petitioner must explain how the proposed combinations of prior art would have rendered the challenged claims unpatentable. At this final stage, we determine whether a preponderance of the evidence of record shows that the challenged claims would have been obvious over the proposed combinations of prior art.

We analyze the instituted grounds of unpatentability in accordance with the above-stated principles.

*B. Level of Ordinary Skill in the Art*

In determining whether an invention would have been obvious at the time it was made, we determine the level of ordinary skill in the pertinent art at the time of the invention. *Graham*, 383 U.S. at 17. “The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991).

Petitioner provides contentions regarding the level of ordinary skill in the art as follows:

A person of ordinary skill in the art (“POSA”) at the time the ’488 patent was filed would have been familiar with the techniques used in performing each of the rendering steps described and claimed in the ’488 patent. The ’488 patent concedes that many of these techniques are well-known and described in widely used texts, incorporating by reference James D. Foley, “Computer Graphics: Principles and Practice” (“Foley”). See Ex. 1001, 1:68-2:7; Ex. 1005 ¶¶ 21, 94.

This section provides specific and particular examples of the level of ordinary skill in the art as reflected by the prior art of record. See *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); cf. *Samsung Electronics Co. Ltd. v. Rembrandt Wireless Techs., LP*, IPR2014-00518, Paper 47 at 17 (Sep. 17, 2015) (“specifying the level of ordinary skill in terms of an academic degree in a field of study and the number of years of practical working experience is generally unhelpful, as a practical matter, because it does not convey whether one with ordinary skill in the art would have been aware of anything specific or particular.”).

As admitted in the ’488 patent and as set forth in prior art texts such as Foley (Ex. 1007), a POSA at the time of filing of the ’488 patent would have been familiar with “conventional” rendering by scan-converting polygons, z-buffering, coordinate transformations, shadow determination using depth information for each light source, and accumulating and applying light from multiple light sources—as described and claimed in the ’488 patent. This person would have been capable of understanding and applying the prior art references discussed herein. Ex. 1005 ¶¶ 94-105.

Pet. 7–8.

Petitioner’s contentions are supported by the Declaration testimony of its Declarant, Mr. Goodin. Ex. 1005 ¶¶ 21, 94–105. More specifically, Mr. Goodin testifies that a person having ordinary skill “in the field of three-dimension graphics rendering” would have been familiar with techniques such as those described in Foley. *Id.* ¶ 94. Mr. Goodin also testifies

regarding details of such rendering techniques including scan-converting polygons, z-buffering, coordinate transformations, shadow determination, and accumulating light. *Id.* ¶¶ 94–105.

Regarding the appropriate level of skill, Patent Owner contends

[A] POSITA is a person with a Bachelor’s of Science degree in electrical engineering, computer science, software engineering, or equivalent, with at least two years of work experience in the field of three-dimensional computer graphics. (Laub, ¶¶24–25.) The District Court in the co-pending litigation adopted this definition of a POSITA, noting that the defendants (Petitioners) did not provide an alternative definition for a POSITA or object to Infernal’s definition. (Ex. 2011, 13.)

PO Resp. 14–15. Patent Owner urges that we adopt its definition of a person having ordinary skill in the art. *Id.* at 16.

Patent Owner’s contentions are supported by the Declaration testimony of its Declarant, Mr. Laub. More specifically, Mr. Laub testifies that a person having ordinary skill in the art would have had the level of skill set forth above i.e., “a Bachelor’s of Science degree in electrical engineering, computer science, software engineering, or equivalent, with at least two years of work experience in the field of three-dimensional computer graphics.” Ex. 2008 ¶ 25. Mr. Laub also testifies regarding technical background of the ’488 patent and, more specifically, prior known rendering techniques. *Id.* ¶¶ 26–45.

We are persuaded of and adopt Patent Owner’s definition of the level of skill of a person having ordinary skill in the art, which is not disputed by Petitioner (Tr. 8:3–12). We note that this is the level of skill adopted by the District Court (PO Resp. 14–16). We agree with Petitioner to the extent that the level of ordinary skill in the art may be reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

For reasons given *infra* III.D.3.d, however, that the skilled artisan would have known of certain aspects of Foley (Tr. 7:13–20) does not relieve Petitioner of its need to provide reasons to combine or modify teachings that Petitioner relies on for establishing unpatentability.

*C. Declarant Testimony*

Petitioner argues that Patent Owner’s Declarant, Mr. Laub, has insufficient familiarity concerning the technological issues at hand. Reply 18–19. More specifically, Petitioner contends that “Mr. Laub’s testimony should be afforded little weight because he has demonstrated a lack of understanding of basic operations used in 3D graphics rendering.” *Id.* at 18–19. Petitioner relies on Mr. Goodin’s testimony to support its unpatentability challenges. *See, e.g.*, Pet. 32. Mr. Goodin testifies that as a result of his experience, he has personal knowledge “of the types of graphics rendering systems in use as of March 1999 in the video game industry and in the animated film industry.” Ex. 1005 ¶ 17.

As to Mr. Laub’s relevant computer generated graphics rendering experience, Mr. Laub testifies that he has “more than 50 years of experience in the field of graphics processing” and “over 40 years of experience in the hands-on product development, research, and management of complex graphics-processing products.” Ex. 2008 ¶ 8. Mr. Laub further testifies that his experience includes “the design of products using 3-D rendering” and “over 35 years of technical consulting experience in the field of graphics processing.” *Id.* Mr. Laub provides additional details regarding his experience, as well as the knowledge that would have been had by a person having ordinary skill in the art. *See, e.g., id.* ¶¶ 9–18, 26–45.

To testify as an expert under Federal Rule of Evidence 702, a person need not be a person of ordinary skill in the art, but rather must be “qualified in the pertinent art.” *Sundance, Inc. v. DeMonte Fabricating Ltd.*, 550 F.3d 1356, 1363–64 (Fed. Cir. 2008); see *SEB S.A. v. Montgomery Ward & Co.*, 594 F.3d 1360, 1372–73 (Fed. Cir. 2010) (upholding a district court’s ruling to allow an expert to provide testimony at trial because the expert “had sufficient relevant technical expertise” and the expert’s “knowledge, skill, experience, training, [and] education . . . was likely to assist the trier of fact to understand the evidence” (citation omitted)); *Mytee Prods., Inc. v. Harris Research, Inc.*, 439 F. App’x 882, 886–87 (Fed. Cir. 2011) (non-precedential) (upholding admission of the testimony of an expert who “had experience relevant to the field of the invention,” despite admission that he was not a person of ordinary skill in the art).

As noted above, Mr. Laub testified that he has significant graphics processing experience and experience in the design of products using 3-D rendering (Ex. 2008 ¶ 8), and this testimony is unrebutted. Also, Petitioner’s argument regarding the insufficiency of Mr. Laub’s familiarity concerning the technological issues at hand is conclusory. For instance, Petitioner identifies only two intricate technological details that Petitioner alleges Mr. Laub does not understand. Reply 19 (citing Ex. 2008 ¶ 39; Ex. 1024, 112:24–25, 113:7, 128:19–21; Ex. 1005 ¶¶ 43–45; Ex. 1026, 103; Ex. 1003, 251; 1007, 668–72). Petitioner’s deposition citations, however, do not support persuasively its contentions. For instance, Petitioner’s citation to page 128, lines 19 through 21 of Mr. Laub’s deposition transcript is merely part of a question posed: “I want you to look at the bottom example in which the blue triangle is behind the red triangle.” Ex. 1024, 128:19–21.

Mr. Laub's other deposition testimony relied upon by Petitioner is set forth below, with the further context of the immediately preceding testimony.

Q. Mr. Laub, what is a shadow map?

A. In the context operative in this matter, shadow map generally describes a listing of regions or places, locations within a scene in which a given light source may be partially or entirely blocked or light from that light source would be partially or entirely blocked.

Q. Is a Z-buffer rendered from the perspective of a light source a shadow map?

A. A Z-buffer rendered or determined from the perspective of a light source will tell you how far any given point in a scene, point on any object in a scene, is from that light source.

Q. And is that an example of a shadow map?

A. No.

Ex. 1024, 112:14–113:7. Mr. Laub's testimony that a shadow map describes from the perspective of a given light source what may be partially or entirely blocked appears consistent with other evidence in the record, including evidence relied upon in the Petition, describing calculating "shadows for a scene by []determining which portions of the various polygons are visible surfaces with respect to the light source." Pet. 11–12 (citing Ex. 1001, 2:14–19).

We are not persuaded that merely not agreeing with Petitioner in response to one question during his deposition regarding the technological detail of what constitutes a shadow map is sufficient reason to give Mr. Laub's testimony little weight. Additionally, Petitioner relies on only attorney argument for these contentions. Petitioner relies on Mr. Goodin's testimony given in his first Declaration only with respect to a z-buffer algorithm in Foley (Ex. 1007, 668–72). Reply 18–19 (citing Ex. 1005

¶¶ 43–45). Mr. Goodin’s testimony identified by Petitioner does not specifically refer to a shadow map, or mention Mr. Laub’s testimony or expertise. *Id.*

Petitioner does not argue persuasively that Mr. Laub does not qualify as a person of ordinary skill in the art at the time of the invention. Based on this record, we are not persuaded by Petitioner. We find Mr. Laub is sufficiently qualified to testify about rendering three-dimensional graphics and the knowledge of one having ordinary skill in the art at the time the ’488 patent was filed.

*D. Obviousness of Claims 1–10 and 27–62*

Petitioner asserts that claims 1–10 and 27–36 are unpatentable, under 35 U.S.C. § 103, as obvious over Segal alone or in combination with McReynolds and claims 37–62 are unpatentable, under 35 U.S.C. § 103, as obvious over Segal. Pet. 18–54, 60; ’930 Pet. 17–53.

*1. Segal*

Segal is directed to an extension to perspective-correct texture mapping that can be used to create various lighting effects. Ex. 1003, 249. Segal’s techniques are used to produce a realistic image of a 3D scene by projecting that scene onto a two-dimensional scene. *Id.* Segal teaches converting a complex scene to polygons. *Id.* Segal also teaches scan-conversion, which yields a series of screen points and corresponding texture points for each polygon. *Id.* at 250. Associated with each screen point is a color and a z-value, denoted  $c$  and  $z$ , respectively. *Id.* Associated with each corresponding texture point is a color and z-value, denoted  $c_T$  and  $z_T$ . *Id.* These values are used to modify corresponding values in a frame buffer of

pixels. *Id.* Each pixel, denoted  $p$ , also has an associate color and  $z$ -value, denoted  $c_p$  and  $z_p$ . *Id.*

Segal additionally teaches a slide projection algorithm consisting of three passes performed for each scan-converted point. *Id.* at 251. Segal's slide projection algorithm is shown below (*id.*):

*Pass 1* If  $z < z_p$ , then  $z_p \leftarrow z$  (*hidden surface removal*)

*Pass 2* If  $z = z_p$ , then  $c_p \leftarrow c_p + c_\tau$  (*illumination*)

*Pass 3* Set  $c_p = c \cdot c_p$  (*final rendering*)

In accordance with Segal's slide projection algorithm, pass 1 is a buffering step that sets the depth ( $z_p$ ) for each pixel. *Id.* at 249, 251. In pass 2 the brightness of each pixel is increased according to the projected spotlight shape. *Id.* at 251. In pass 3 the scene is drawn by modulating the color by the corresponding color of the projected image and incorporating texture mapping. *Id.* Segal teaches that the projected image may be made to have a particular focal plane by rendering the scene several times and using an accumulation buffer. *Id.* Segal also teaches that a similar technique may be used to simulate the effects of spotlight illumination on a scene. *Id.*

Segal additionally teaches an application of this technique to produce shadows. *Id.* To produce shadows, first an image of the scene is rendered from the viewpoint of the light source. *Id.* An array of values corresponding to a hidden surface-removed image is then placed into a texture map. *Id.* The generated texture map is used in a three-pass rendering process, which is shown below (*id.*):

*Pass 1* If  $z < z_p$ , then  $z_p \leftarrow z$ ,  $c_p \leftarrow c$  (*hidden surface removal*)

*Pass 2* If  $z_\tau = z^t$ , then  $\alpha_p \leftarrow 1$ ; else  $\alpha_p \leftarrow 0$  (*shadow testing*)

*Pass 3*  $c_p \leftarrow c_p + (c \text{ modulated by } \alpha_p)$  (*final rendering*)

In accordance with Segal's shadow effect algorithm, pass 1 produces hidden surface-removal. *Id.* In pass 2, a comparison is performed to determine if a point is visible from the light or is in shadow. *Id.* In pass 3, the scene is drawn with full illumination and portions of the scene are brightened that are not in shadow. *Id.*

Segal further teaches that illumination from multiple colored lights may be produced by performing multiple passes. *Id.* Additionally, according to Segal, the shadow effect may be combined with the spotlight effect. *Id.*

## 2. *McReynolds*

McReynolds is directed to using Open Graphics Library (OpenGL) techniques to generate images with greater realism and utility. Ex. 1004, 1. For instance, McReynolds teaches breaking a shading process into two passes, including a first pass of writing a diffuse reflectance computation into a color buffer and a second pass of adding a specular highlight computation into the image frame. *Id.* at 25. McReynolds also teaches an algorithm with three passes for rendering a scene with spotlight illumination. *Id.* at 27. At the end of the first pass, an ambient illumination is established in the color buffer and a depth buffer. *Id.* In the second pass, illumination from the spotlight is accumulated in the color buffer. *Id.* In the final pass, the scene is drawn with the colors modulated by the illumination accumulated in the first two passes. *Id.*

McReynolds further teaches an "accumulation buffer" that "is designed for integrating multiple images." *Id.* at 43. To maintain accuracy over multiple blending operations, the accumulation buffer has a high number of bits per color component. *Id.* The accumulation buffer is used

for rendering softer shadows. *Id.* at 45. In particular, shadows from multiple, separate light sources are accumulated to create scenes containing shadows resulting from contributions of all the lights in the scene. *Id.*

3. *Claim 1*

a. *The Petition*

We start with the analysis in the Petition that claim 1 of the '488 patent is obvious over Segal alone. Pet. 18–41, 50–54.<sup>5</sup> Petitioner relies on a combination of Segal's teachings for the elements recited in claim 1. *Id.* at 27. More specifically, Petitioner relies on Segal's teachings relating to different applications of projective texture mapping that produce slide projector, spotlight, and shadow effects. *Id.* Petitioner, additionally, relies on certain of Segal's teachings in a section entitled "Mathematical Preliminaries." See, e.g., *id.* at 22 (citing Ex. 1003, Fig. 2).

Petitioner also provides the proposed combination below.

|                    |                                                                                                                         |
|--------------------|-------------------------------------------------------------------------------------------------------------------------|
| Spotlight          | <i>Pass 1</i> If $z < z_p$ , then $z_p \leftarrow z$ ( <i>hidden surface removal</i> )                                  |
| Shadow             | <i>Pass 2</i> If $z_\tau = z^t$ , then $\alpha_p \leftarrow 1$ ; else $\alpha_p \leftarrow 0$ ( <i>shadow testing</i> ) |
| Spotlight + Shadow | <i>Pass 2</i> If $z = z_p$ , then $c_p \leftarrow c_p + c_\tau \cdot \alpha_p$ ( <i>illumination</i> )                  |
| Spotlight          | <i>Pass 3</i> Set $c_p = c \cdot c_p$ ( <i>final rendering</i> )                                                        |

*Id.* at 27.

With respect to a reason a person having ordinary skill in the art would have had to combine and modify Segal's teachings in this manner, Petitioner contends as follows, "Segal instructs that '[t]he shadow effect may also be combined with the spotlight effect described above, as shown in

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<sup>5</sup> Claim 1 is challenged in IPR2016-00929 so citations are to the papers and exhibits filed in that case.

Figure 4.” Pet. 27 (quoting 1003, 251). Petitioner, however, acknowledges that an inquiry remains. *Id.* at 38. In particular, Petitioner contends “the inquiry centers around the *design choices* a POSA would consider to implement the combination.” *Id.* at 38 (emphasis added). Petitioner further contends,

A POSA familiar with the system and techniques disclosed in Segal would thus look to Segal’s express teaching regarding combining shadow effects with spotlight effects as discussed above, and recognize that it would be an obvious design choice to implement these features in Pass 2 of Segal’s process to achieve an enhanced image with both illumination and shadow features, such as later shown in Fig. 4 above. Ex. 1005 ¶ 196. Such a design choice would be obvious at least because Segal’s “shadow testing” step creates a value,  $\alpha_p$ , that is stored as an “additional framebuffer value.” *Id.* Because  $\alpha_p$  is stored in the framebuffer, it is readily available for use in conjunction with the “illumination” step in Pass 2 of the combined rendering process. *Id.*

*Id.* at 39; *see also id.* at 27 (“[A] POSA would have understood that when the shadow effect is combined with the spotlight effect, then the ‘illumination’ step in Pass 2 of the spotlight effect is performed only if the spotlight actually illuminates the scene at that point.”).

*b. Patent Owner’s Response*

Patent Owner contends that “[Petitioner alleges] their proposed combination would have been a design choice for a POSITA. (Petition, 38–39.) However, Petitioners never explain how a POSITA would know to take the prior art techniques enumerated in Petitioners’ discussion of a POSITA, and make the combination and associated modifications to Segal.” PO Resp. 26. Patent Owner further contends,

Petitioners cite to a solitary sentence from Segal to support their argument: “The shadow effect may [] be combined with the

spotlight effect described above, as shown in Figure 4.” (Petition, 37-38; *citing* Segal, 251.) From this isolated sentence, Petitioners conclude that the combination would have been a design choice for a POSITA because “it merely combines two known techniques (shadow effect and spotlight effect) to accomplish the result described and depicted in Segal.” (Petition, 38.) But, Petitioners’ unsupported statement that the combination would have been merely a design choice is insufficient to establish obviousness: “[t]he mere recitation of the words ‘common sense’ or ‘design choice,’ however, without any evidentiary support, adds nothing to the obviousness equation.” *See Stryker Corp. v. Karl Storz Endoscopy-America, Inc.*, IPR2015-00677, Paper 15 at 37 (P.T.A.B. Sept. 2, 2015). Furthermore, Petitioners’ combination is not merely a matter of design choice. Unlike *KSR*, which held that it was an obvious design choice to place an electronic sensor on a fixed pivot point of a mechanical structure to avoid wire-chafing problems, Petitioners manufacture a three-pass process by modifying, deleting, and correcting components from each of Segal’s applications. (*Compare* Petition, 27, with *KSR Int’l Co.*, 550 U.S. 398, 424-25 (2007).)

PO Resp. 28. Patent Owner also characterizes Petitioner’s approach as “modify[ing] [Segal’s] disclosures on the fly—correcting errors and filling in omissions based on their expert’s 35 years of graphics experience,” using “impermissible hindsight.” *Id.* at 13.

Patent Owner provides detailed contentions regarding specific flaws in Petitioner’s contentions. For instance, Patent Owner contends that Petitioner’s analysis is deficient as follows: (1) Petitioner does not describe “any initialization for their combination nor do they describe how, if, or when the texture maps of either slide projection application or shadow determination application are created or used in their three pass process” (*id.* at 29); (2) Petitioner provides unpersuasive explanation as to why a person having ordinary skill in the art would have eliminated the accounting for

color in Pass 1 of the shadow application (*id.*); (3) Petitioner’s combination of Pass 2 of the slide projector application with a modified version of Pass 2 of the shadow determination “omits important details” regarding the transformation asserted by Petitioner and “how Segal’s slide projector texture map is used in the combination” (*id.* at 30); and (4) Petitioner does not explain persuasively why their proposed combination for a shadow rendering method uses Pass 3 from the slide projector application rather than Pass 3 of the shadow determination (*id.* at 32). Patent Owner, additionally, contends that Petitioner’s combination would have been reached only by an expert in the field, not a person having ordinary skill in the art. *Id.* at 26.

*c. Petitioner’s Reply*

In its Reply, Petitioner contends Patent Owner “contrives a series of obstacles that supposedly would prevent a POSA from achieving Segal’s proposed combination. (Response, 29–32.) None is persuasive.” Reply 16. Petitioner, however, does not respond to Patent Owner’s contentions that Petitioner’s design choice contentions are conclusory (*see, e.g.*, PO Resp. 28). Additionally, Petitioner responds to only some, but not to all of Patent Owner’s alleged specific deficiencies. Reply 16–18. For instance, regarding Patent Owner’s contentions relating to Pass 1 (PO Resp. 29), Petitioner contends that the accounting for color in Pass 1 of the shadow application is not required to accomplish hidden surface removal because the spotlight application already has a mechanism for handling ambient illumination. Reply 16 (citing Ex. 1023 ¶ 40). Regarding Patent Owner’s contentions relating to Pass 2 (PO Resp. 29–30), Petitioner contends that Segal’s slide projector texture map is used in the combination in the same manner as the

original pass of the slide projector application. Reply 17 (citing Ex. 1023 ¶ 41).

*d. Overview of the Analysis*

A mere design choice, which does not need to be shown explicitly in the prior art, is generally a minor and obvious choice that solves no stated problem. *Cf. In re Kuhle*, 526 F.2d 553, 555 (CCPA 1975) (“Use of such a means of electrical connection in lieu of those used in the references solves no stated problem and would be an obvious matter of design choice within the skill [in] the art.” (citations omitted)); *see also In re Gal*, 980 F.2d 717, 719–20 (Fed. Cir. 1992) (finding of “obvious design choice” precluded where the claimed structure and the function it performs are different from the prior art). Thus, “design changes that [do] not ‘result in a difference in function or give unexpected results’ [are] ‘no more than obvious variations consistent with the principles known in th[e] art’ of the patent at issue in [the] case” are obvious design choices. *TRW Auto. US LLC*, Case IPR2014-00251, slip op at 6 (PTAB July 31, 2014) (Paper 18) (quoting *In re Rice*, 341 F.2d 309, 314 (CCPA 1965)).

Here, the three-pass algorithm, which is alleged to be the design choice(s), is exactly the problem the invention alleges to solve. For example, the Specification states “the transformation process associated with converting between the camera, world, and light viewpoints in support of this type of two pass [shadow] algorithm can prove to be too burdensome, thereby inhibiting or otherwise diminishing the effectiveness of the resulting interactive real-time graphics.” Ex. 1001, 2:62–67; *see N. Telecom, Inc. v. Datapoint Corp.*, 908 F.2d 931, 936 (Fed. Cir. 1990) (finding that “a significant aspect of the ’375 invention as a whole” was not a design

choice). Thus, the motivation for the purported design choices, i.e., that the choices were made in service of specifically improving upon the prior art two pass shadow algorithm, militates against those choices being considered mere design choices. Additionally, the “design choice” concept was not intended to encompass making extensive modifications to a reference. *See Kuhle*, 526 F.2d at 555 (citing several cases as the basis for the design choice concept). Given that understanding, we find the structural features recited in claim 1 would result in a “difference in function” as compared to the structural configuration of Segal, i.e., the spotlight algorithm of Segal does not perform the function of comparing the camera view to the light source view as part of the three-step process required by the claims. *Ex. 1001*, 2:62–67. Below, we discuss the specific aspects of Petitioner’s design choice contention.

We agree with Patent Owner that Petitioner’s design choice contentions are conclusory. *See Cutsforth, Inc. v. MotivePower, Inc.*, 636 F. App’x 575, 578 (Fed. Cir. 2016) (nonprecedential) (“Merely stating” a modification “is a design choice does not make it obvious.”). As Petitioner acknowledges Segal’s teaching that “[t]he shadow effect may also be combined with the spotlight effect described above, as shown in Figure 4” alone is not an articulated reason why one having ordinary skill in the art would have combined and modified the various teachings identified by Petitioner and an inquiry remains. *Pet. 38*. Although Petitioner contends “the inquiry centers around the *design choices* a POSA would consider to implement the combination” (*id.* (emphasis added)), Petitioner identifies only a single alleged design choice (*see, e.g., id.* at 27). To the extent that other design choices would have been obvious to one having ordinary skill

in the art, Petitioner does not identify these other design choices or explain persuasively why a person having ordinary skill in the art would have chosen the particular combination and modification set forth in the Petition. *See In re Rouffet*, 149 F.3d 1350, 1357 (Fed. Cir. 1998) (a finding of obviousness requires an explanation of why a “skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed”), *overruled on other grounds by KSR*, 550 U.S. at 419–20 (overruling rigid application of the teaching, suggestion, or motivation test but not the requirement that a finding of obviousness be explained).

We now turn to whether Petitioner has established that the particular alleged design choice set forth by Petitioner (Pet. 27) would have been obvious. An invention “composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR*, 550 U.S. at 418. Instead, a determination of unpatentability on a ground of obviousness must include “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id.* (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). The obviousness evaluation “should be made explicit,” and it “can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.” *Id.*

Petitioner’s contentions are deficient regarding its alleged single design choice. In particular, Petitioner provides contentions regarding why one having ordinary skill in the art would have made a determination

regarding which pixels are in shadow prior to making other determinations, but Petitioner does not explain persuasively how or why one having ordinary skill in the art would have made each of the combinations and modifications set forth in its particular alleged design choice.

Regarding the determination of which pixels are in shadow, Petitioner contends “a POSA would have understood that when the shadow effect is combined with the spotlight effect, then the ‘illumination’ step in Pass 2 of the spotlight effect is performed only if the spotlight actually illuminates the scene at that point.” Pet. 27 (citing Ex. 1005 ¶¶ 155–58); *see also id.* at 39 (“The portion of the rendering process for the ‘spotlight effect’ that ‘brightens’ the scene is the ‘illumination’ step, Pass 2: ‘Pass 2 increases the brightness of each pixel according to the projected spotlight shape . . . .’” (emphasis omitted) (citing Ex. 1003, 251)). Petitioner relies on Mr. Goodin’s testimony, as well as teachings in Segal for this contention. Mr. Goodin testifies that “Segal itself suggests that solution, by explaining that the ‘shadow map’ for each light source is used to ‘brighte[n] portions of the scene that are not in shadow.’” Ex. 1005 ¶ 157 (emphasis omitted) (citing Ex. 1003, 251). Mr. Goodin further testifies “[t]he portion of the rendering process for the ‘spotlight effect’ that ‘brightens’ the scene is the ‘illumination’ step, Pass 2.” *Id.*

Mr. Goodin’s testimony is consistent with Segal’s teachings that a person having ordinary skill in the art would have known to apply a determination of whether a point is in shadow prior to performing the illumination step. Patent Owner, however, contends that a person having ordinary skill in the art would not have had “the technical expertise to fill in the gaps in Segal or to correct Segal’s errors.” PO Resp. 25 (citing Ex. 2008

¶¶ 25, 84, 113–117). Patent Owner relies on the testimony of Mr. Laub that Segal “does not provide any specifics or detail of how to do that combining.” Ex. 2008 ¶ 112. Mr. Laub further testifies regarding another proposed combination and deficiencies in Petitioner’s analysis. *Id.* ¶¶ 112–117. For instance, Mr. Laub testifies that the skilled artisan would have had to “decide selectively to combine, discard, or modify various pieces of the ‘Slide Projector’ and ‘Fast, Accurate, Shadows’ applications.” *Id.* ¶ 113. Petitioner relies on its contentions that Mr. Laub’s testimony should be given minimal weight. *See, e.g.*, Reply 18–19. We disagree, and we credit the testimony of Mr. Laub.

Additionally, Petitioner’s rationale alone does not provide a reason to combine or modify Segal’s teachings as proposed by Petitioner. More specifically, for a person having ordinary skill in the art to apply this determination, according to Petitioner, a person having ordinary skill in the art would have performed Pass 2 of the shadow algorithm before Pass 2 of the spotlight algorithm. *See, e.g.*, Pet. 27. Petitioner, however, does not provide how or why a person having ordinary skill in the art would modify the spotlight algorithm to obtain  $z_r$  and  $z^t$  values that are needed to perform Pass 2 of the shadow algorithm, as set forth in its proposed combination. *See, e.g., id.*

Petitioner also contends its alleged design choice would have been obvious because “Segal’s ‘shadow testing’ step creates a value,  $\alpha_p$ , that is stored as an ‘additional framebuffer value,’” that “is readily available for use in conjunction with the ‘illumination’ step in Pass 2 of the combined rendering process.” *Id.* at 39 (citing Ex. 1005 ¶ 196). As Petitioner contends, Segal teaches using “an additional framebuffer value  $\alpha_p$ ” in the

shadow algorithm. Ex. 1003, 251. Nevertheless, that such an additional framebuffer value is readily available for use alone does not explain persuasively why one having ordinary skill in the art, as defined in this case, would have modified the spotlight algorithm in the manner set forth in the Petition or remedy the aforementioned deficiency regarding obtaining  $z_\tau$  and  $z^t$  values to perform the comparison.

In consideration of the full record before us, we are not persuaded by Petitioner's contentions regarding reasons to combine the teachings of Segal. Below, we discuss in more detail Petitioner's contentions regarding obtaining  $z_\tau$  and  $z^t$  values to perform the comparison.

*e. Deficiency Regarding Obtaining  $z_\tau$  and  $z^t$  Values*

Patent Owner provides more detailed contentions regarding the deficiencies in Petitioner's analysis (PO Resp. 29–32), which are consistent with the record and are not addressed persuasively in Petitioner's Reply. We discuss Petitioner's proposed combination and the aforementioned deficiency regarding obtaining  $z_\tau$  and  $z^t$  values to perform the comparison with respect to Pass 2 of the shadow algorithm, shown annotated in a red box in Petitioner's proposed combination and modification.

|                    |                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Spotlight          | <i>Pass 1 If <math>z &lt; z_p</math>, then <math>z_p \leftarrow z</math> (hidden surface removal)</i>                                         |
| Shadow             | <i>Pass 2 If <math>z_\tau = z^t</math>, then <math>\alpha_p \leftarrow 1</math>; else <math>\alpha_p \leftarrow 0</math> (shadow testing)</i> |
| Spotlight + Shadow | <i>Pass 2 If <math>z = z_p</math>, then <math>c_p \leftarrow c_p + c_\tau \cdot \alpha_p</math> (illumination)</i>                            |
| Spotlight          | <i>Pass 3 Set <math>c_p = c \cdot c_p</math> (final rendering)</i>                                                                            |

Table Depicting Petitioner's Proposed Combination Annotated to Highlight *Pass 2 If  $z_\tau = z^t$ , then  $\alpha_p \leftarrow 1$ ; else  $\alpha_p \leftarrow 0$  (shadow testing)*

Pet. 27 (with annotation). As shown in the annotated version of Petitioner's proposed combination above, Pass 2 of the shadow algorithm includes a comparison of  $z_\tau$  and  $z^t$ . *Id.*

First, we turn to Segal's  $z_\tau$  value, which Petitioner contends is "lighting data" (*id.* at 33–35). Patent Owner persuades us that certain of Segal's teachings relied upon by Petitioner are not included in Petitioner's proposed combination and modification, and also are not addressed in Petitioner's reasons to combine. PO Resp. 21–24; Pet. 27, 38, 39. For instance, Patent Owner contends "[c]ritical to the shadow application is a pre-pass process," which Patent Owner refers to as "PASS 0." PO Resp. 21. Patent Owner contends that "PASS 0 effectively performs hidden surface removal from the perspective of the light source," but Petitioner does not "provide these missing details." *Id.* (emphasis omitted). Patent Owner further contends that Petitioner does not describe "any initialization for their combination nor do they describe how, if, or when the texture maps of either slide projection application or shadow determination application are created or used in their three pass process." *Id.* at 29.

Segal's teaching regarding "PASS 0" (*id.*) is reproduced below:

First, an image of the scene is rendered from the viewpoint of the light source. The purpose of this rendering is to obtain depth values in light coordinates for the scene with hidden surfaces removed. The depth values are the value of  $z^l/w^l$  at each pixel in the image. The array of  $z^l$  values corresponding to the hidden surface-removed image are then placed into a texture map, which will be used as a shadow map [10][8]. We refer to a value in this texture map as  $z_\tau$ .

Ex. 1003, 251. Consistent with the Petition (Pet. 33–35), Segal teaches that its  $z_\tau$  value is rendered from the viewpoint of the light source.

Consistent with Patent Owner's contentions (PO Resp. 21, 29–32), however, Petitioner's proposed combination does not take into account the need to perform the pre-pass (referred to by Patent Owner as "PASS 0"). *See, e.g.*, Pet. 27. For instance, Petitioner does not explain persuasively when in the combination of the various passes the pre-pass to create  $z_t$  would be performed or how or why one having ordinary skill in the art would have included this pre-pass in Petitioner's proposed combination. *See, e.g., id.* at 27, 38, 39 (discussing only reasons relating to whether shadows are illuminated). Petitioner relies on Segal's teaching of this pre-pass for "providing lighting data," which are the same lighting data used in the comparison step recited in claim 1, i.e., "comparing . . . with at least a portion of *said lighting data*." *Id.* at 33–36. In its Reply, Petitioner does not address persuasively Patent Owner's arguments. *See e.g.*, Reply 1, 16–18.

Second, we turn to Segal's  $z^t$  value, which Petitioner contends is "observer data" used in the comparison. Pet. 32–35. Patent Owner again persuades us that Petitioner's contentions are deficient. For instance, Patent Owner contends "Segal does not disclose the meaning of  $z^t$  in the shadow application or how to derive this value." PO Resp. 23. Patent Owner also contends,

Next, Petitioners combine PASS 2 of the slide projector application with a modified version of PASS 2 of the shadow determination application. But, Petitioners' combination omits important details. For example, Figure 4 of Segal, which Petitioners use as part of their motivation for the combined process, implies that both a shadow map and a slide projector texture map are used in a combined process. Yet, Petitioners do not explain how Segal's slide projector texture map is used in the combination. Also, Petitioners state that in PASS 2, "each screen point (pixel) is transformed into light space, first to test if that point is in shadow." (Petition, 28.) But, as Infernal detailed

above, nowhere does Segal teach or suggest this transformation; nor do Petitioners explain why a POSITA would have thought to perform this transformation.

PO Resp. 30.

We are persuaded by Patent Owner (*see, e.g.*, PO Resp. 29–32) that Petitioner does not explain persuasively (1) how or why one having ordinary skill in the art would have combined and modified Segal’s teachings such that the same observer data provided in Pass 1 in the algorithm identified by Petitioner as “Spotlight” (Pet. 27) are used in Pass 2 in the algorithm identified by Petitioner as “Shadow” (*id.*); and (2) why one having ordinary skill in the art would have combined and modified Segal’s teachings so as to transform observer data to  $z^t$  to use in the comparison. *See, e.g.*, Pet. 27, 38, 39 (discussing only reasons relating to illuminating portions of a scene not in a shadow).

We first turn Petitioner’s lack of persuasive explanation of how or why one having ordinary skill in the art would have combined and modified Segal’s teachings such that the same observer data provided in Pass 1 in the algorithm identified by Petitioner as “Spotlight” (Pet. 27) are used in Pass 2 in the algorithm identified by Petitioner as “Shadow” (*id.*). For context, we refer to the recitations of “providing *observer data*” and “comparing at least a portion of *said observer data*” in claim 1. For these recitations, Petitioner points to the result of the first pass of Segal’s rendering process and  $z^t$ , respectively. Pet. 33–36. Petitioner’s proposed combination and modification of Segal’s teachings is shown below with the first pass of Segal’s rendering process annotated in blue (corresponding to “providing observer data”) and  $z^t$  annotated in red (corresponding to “said observer data” that are used in the comparison recited in claim 1).

|                    |                                                                                                                         |
|--------------------|-------------------------------------------------------------------------------------------------------------------------|
| Spotlight          | <i>Pass 1</i> If $z < z_p$ , then $z_p \leftarrow z$ ( <i>hidden surface removal</i> )                                  |
| Shadow             | <i>Pass 2</i> If $z_\tau = z^t$ , then $\alpha_p \leftarrow 1$ ; else $\alpha_p \leftarrow 0$ ( <i>shadow testing</i> ) |
| Spotlight + Shadow | <i>Pass 2</i> If $z = z_p$ , then $c_p \leftarrow c_p + c_\tau \cdot \alpha_p$ ( <i>illumination</i> )                  |
| Spotlight          | <i>Pass 3</i> Set $c_p = c \cdot c_p$ ( <i>final rendering</i> )                                                        |

Table Depicting Petitioner’s Proposed Combination Annotated to Highlight *Pass 1* If  $z < z_p$ , then  $z_p \leftarrow z$  (*hidden surface removal*) and  $z^t$  in *Pass 2* (*shadow testing*)

Pet. 27 (annotated).

In the Petition, Petitioner contends only “the z-value of the screen point transformed into light source space,  $z^t$ ” corresponds to “said observer data” that are used in the comparison. *Id.* at 35–36. Consistent with Patent Owner’s contentions (PO Resp. 30), however, the Petition does not explain persuasively how  $z^t$  annotated in red above is provided in the first pass, i.e., Pass 1 annotated in blue above. Petitioner contends only that the z-value of the screen point is transformed into light source space (Pet. 35), which is conclusory. That the z-value used in the shadow algorithm is transformed is not itself persuasive argument or evidence that it is the same observer data obtained in Pass 1 of the spotlight algorithm, or that such a modification or combination of Segal’s teachings would have been obvious.

Petitioner does not remedy this deficiency in its Reply. Reply 1, 4, 5, 9–10. To the extent Petitioner provides further contentions in its Reply, these contentions pertain to only converting “a screen point” or Segal’s “iterated  $z^t$ ,” but these contentions do not address persuasively converting the same observer data received in Pass 1. *See, e.g.*, Reply 1. To meet the claim recitation the iterated  $z^t$ , for example, must result from Pass 1 of the Spotlight algorithm, and Petitioner fails to address this.

Petitioner also relies on the testimony of Mr. Goodin. Pet. 35–36 (citing Ex. 1005 ¶¶ 186–88). Like Petitioner’s contentions in the Petition, Mr. Goodin testifies only that “the rendering process compares the z-value of the screen point transformed into light source space,  $z^t$ .” Ex. 1005 ¶ 187 (citing Ex. 1003, 251). Mr. Goodin does not testify that the z-value of the screen point is provided as the result of Pass 1 of the Spotlight algorithm. *Id.* ¶¶ 186–88. Additionally, Mr. Goodin’s testimony is conclusory and does not remedy the deficiency in the Petition. 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”).

We now turn to Patent Owner’s contentions that Petitioner does not explain persuasively why one having ordinary skill in the art would have combined and modified Segal’s teachings so as to transform observer data to  $z^t$  to use in the comparison. *See, e.g.*, PO Resp. 29–32 (citing e.g., Ex. 2008 ¶¶ 115, 117); *see also id.* at 35 (“[T]he shadow application shows that both  $z^t$  and  $z_r$  values are derived from the light source perspective.” (citing Ex. 2008 ¶¶ 120–127)). We again are persuaded by Patent Owner that Petitioner’s contentions are deficient in this regard. The Petition includes only a conclusory contention that “the z-value of the screen point transformed into light source space,  $z^t$ ” corresponds to “said observer data” that are used in the comparison. Pet. 35–36 (citing Ex. 1005 ¶¶ 186–88). Petitioner’s reasons to combine Segal’s teachings do not provide sufficient argument or evidence regarding how or why one of ordinary skill in the art would have combined Segal’s teachings regarding Mathematical Preliminaries to transform observer data. *Id.* at 27, 38, 39.

Petitioner's Reply contentions do not remedy the aforementioned deficiency. Indeed, Petitioner's Reply (*id.* at 16–18) mentions only a subset of the disputes raised by Patent Owner (PO Reply 29–32). Additionally, Patent Owner supports its contentions with the testimony of Mr. Laub. *See, e.g.*, PO Resp. 29–32 (citing *e.g.*, Ex. 2008 ¶¶ 115, 117); *see also id.* at 35 (“[T]he shadow application shows that both  $z^t$  and  $z_r$  values are derived from the light source perspective.” (citing Ex. 2008 ¶¶ 120–127)). For instance, Mr. Laub testifies that “Segal does not teach that its  $z^t$  values are transformed observer data” and that “[n]o transformation from any other coordinate system, let alone Segal's clip or screen coordinate systems from the observer perspective, is involved in Segal's definition of  $z^t$ .” Ex. 2008 ¶ 122.

In its Reply, Petitioner contends “Section 2 of Segal explains the mathematics of converting a screen point into the perspective of a light source.” Reply 1. Petitioner also contends:

Segal refers to the process of mapping the polygons in the scene onto pixels from the perspective of the observer, and finding the corresponding “texture coordinates” in the perspective of a light source as “iteration”: “Scan conversion uses iteration to enumerate pixels on the screen that are covered by each polygon. This iteration in the plan of projection introduces a homogeneous variation into the parameters that index the texture of a projected polygon. We call these parameters *texture coordinates*.” (Ex. 1003, 249). Segal also discloses that “[g]iven  $(x^s, y^s)$ , a point on a scan-converted polygon, our goal is to find its corresponding texture coordinates,  $(x^t, y^t)$ .” (*id.*, 250).

Reply 5. Petitioner further contends because of the “purpose of the iteration process” and the “consistent use of the word ‘iteration’ and its variants” “Section 2 of Segal” is clear that “the corresponding texture points are

generated by converting screen points into texture coordinates.” *Id.* at 9–10 (citing Ex. 1003, 250–51; Ex. 1023 ¶¶ 4–22, 32).

Petitioner’s Reply contentions primarily related to whether “the iterated  $z^t$ ” is transformed observer data. *Id.* We agree with Petitioner that “Section 2 of Segal explains the mathematics of converting a screen point into the perspective of a light source.” *Id.* at 1. However, Petitioner has not shown by a preponderance of the evidence, how and why a person having ordinary skill in the art would have combined or modified the Mathematical Preliminaries teachings with other of Segal’s teachings to arrive at the claimed subject matter. Additionally, Mr. Laub’s testimony that “Segal does not teach that its  $z^t$  values are transformed observer data” and that “[n]o transformation from any other coordinate system, let alone Segal’s clip or screen coordinate systems from the observer perspective, is involved in Segal’s definition of  $z^t$ ” (Ex. 2008 ¶ 122) is consistent with Segal’s teachings (Ex. 1003, 251).

In this regard, Petitioner provides two responsive contentions in its Reply as follows: (1) Segal’s reference to “iteration” and its variants makes clear that “the iterated  $z^t$ ” is transformed observer data (Reply 5, 9–10); and (2) the “purpose of the iteration process” is to find corresponding coordinates (*id.* at 9–10 (citing Ex. 1003, 250–51; Ex. 1023 ¶¶ 4–22, 32)).

We first turn to whether Segal’s reference to “iteration” and its variants makes clear that “the iterated  $z^t$ ” is transformed observer data (*id.* at 5, 9–10). Certain of Petitioner’s contentions are consistent with Segal’s teachings. For instance, Segal teaches transformations, e.g., “[g]iven  $(x^s, y^s)$ , a point on a scan-converted polygon, our goal is to find its corresponding texture coordinates,  $(x^t, y^t)$ .” Ex. 1003, 250. Additionally, the word

“iteration” is used in connection with the Mathematical Preliminaries section. For instance, Segal’s Mathematical Preliminaries teachings are introduced as follows: “[t]o aid in describing this iteration process, we introduce four coordinate systems.” *Id.* at 249.

Upon consideration of Segal’s teachings in their entirety, as well as Petitioner’s arguments and evidence, however, we are not persuaded by Petitioner that Segal’s reference to “iteration” and its variants makes clear that “the iterated  $z^t$ ” is transformed observer data (Reply 5, 9–10). For instance, consistent with Patent Owner’s contentions (*see, e.g.*, PO Resp. 37), with respect to Mathematical Preliminaries, Segal teaches multiple coordinate systems including a “*light* coordinate system” that has an “origin” “at the light source.” Ex. 1003, 249–50.

Similarly, Petitioner has not shown persuasively that mere reference to texture coordinates,  $(x^t, y^t)$  is enough. Consistent with Patent Owner’s contentions (PO Resp. 23–24), Segal teaches an example of rendering a scene “from the viewpoint of the light source” that results in an “array of  $z^t$  values.” Ex. 1003, 251.

Second, we turn to whether the “purpose of the iteration process” is to find corresponding coordinates (Reply 9–10 (citing Ex. 1003, 250–51; Ex. 1023 ¶¶ 4–22, 32)). As support, Petitioner cites to declaration testimony provided by Petitioner in its Reply Declaration. Reply 9–10 (citing Ex. 1003, 250–51; Ex. 1023 ¶¶ 4–22, 32). Mr. Goodin testifies, for example, [t]he Segal paper, in its entirety, is about the transformation of screen points (‘observer data’) into points in texture space (‘lighting data’).” Ex. 1023 ¶ 4. Mr. Goodin testifies that Segal’s Mathematical Preliminaries teachings support his conclusion. Ex. 1023 ¶¶ 4–22. Mr. Goodin’s testimony repeats

certain of Segal's teachings. *Id.* However Mr. Goodin's testimony that the Segal paper "in its entirety" is about the required transformation is conclusory and does not take into account other of Segal's teachings including, for example, those relating to the array of  $z^t$  values that are obtained by rendering an image of a scene from the viewpoint of the light source (Ex. 1003, 251). Because we are not persuaded by Mr. Goodin's testimony, we need not consider whether his testimony is properly responsive to arguments in Patent Owner's Response.

Additionally, Petitioner's citations to Mr. Goodin's declaration (Reply 9–10 (citing Ex. 1003, 250–51; Ex. 1023 ¶¶ 4–22, 32)) include citations to testimony, but Petitioner does not explain persuasively the relevance of this testimony in its Reply. For instance, Petitioner cites Mr. Goodin's testimony regarding Foley and the claimed comparison (Ex. 1023 ¶ 8 (citing 1007 ¶ 230)), but Petitioner has not provided persuasive argument or explanation in its Reply regarding Foley. *See* 37 C.F.R. § 42.6(a)(3) ("Arguments must not be incorporated by reference from document into another document. Combined motions, oppositions, replies, or other combined documents are not permitted."). Accordingly, we need not determine whether Mr. Goodin's Reply Declaration testimony raises new issues or belatedly presents evidence. Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,767 (Aug. 14, 2012).

In its Reply, Petitioner also cites the Decision on Institution. Reply 4, 9 (citing Dec. on Inst. 25–27). In our Decision on Institution, we noted that Segal teaches that Pass 2 in the shadow determination "requires that the mechanism for setting  $\alpha_p$  be based on the result of a *comparison* between a value stored in the texture map and the iterated  $z^t$ ." Dec. on Inst. 25 (citing

Ex. 1003, 251). Petitioner’s reliance on a reference to this teaching in the Decision on Institution, however, is misplaced. Although Patent Owner provided certain contentions disputing Petitioner’s proposed combinations with respect to storing data in a buffer, which we discussed in the Decision on Institution (*see, e.g., id.* at 36–37), as noted in that Decision (*id.* at 29–30) at the institution stage, Patent Owner did not dispute Petitioner’s contentions regarding combining or modifying Segal’s teachings relating to the spotlight and shadow effects. Furthermore, as indicated in the Decision on Institution, at the institution stage we had not “made a final determination with respect to the patentability of any claim.” *Id.* at 43.

In summary, Petitioner does not explain persuasively how or why a person having ordinary skill in the art would have combined or modified the teachings in Segal relied upon by Petitioner. As set forth above, Petitioner’s contentions are deficient regarding obtaining  $z_\tau$  and  $z^t$  values to perform the comparison with respect to Pass 2 of the shadow algorithm, relied upon for teaching “comparing at least a portion of said observer data with at least a portion of said lighting data,” recited in claim 1.

*f. Level of Skill*

As a further, independent reason for our decision, we now turn to Patent Owner’s contentions that Petitioner’s combination would have been reached only by an expert in the field, not a person having ordinary skill in the art. PO Resp. 26. For the reasons set forth *supra* III.B, we adopt Patent Owner’s definition the level of skill of a person having ordinary skill in the art. *Id.* at 14–16. More specifically, we adopt Patent Owner’s contention that “a POSITA is a person with a Bachelor’s of Science degree in electrical engineering, computer science, software engineering, or equivalent, with at

least two years of work experience in the field of three-dimensional computer graphics.” *Id.* at 14–15 (citing Ex. 2008 ¶¶ 24–25). Petitioner has not shown that a person of the skill level we determine is proper would have reached the Petitioner’s combination.

During the Hearing, Petitioner argued that Patent Owner’s definition is not inconsistent with Petitioner’s contentions regarding the level of skill, but Petitioner acknowledged that this argument is not anywhere in the record.

JUDGE MOORE: And other than in here today, is there anywhere in the record that you stated that?

MR. TAUB: That the two definitions are consistent, Your Honor?

JUDGE MOORE: Yes.

MR. TAUB: Not that I’m aware of in a briefing, Your Honor. Certainly it’s true, though. I’m not aware of any statement to the contrary in any of Patent Owner’s submissions that somehow a person of ordinary skill in the art would not understand or be familiar with the techniques that are set forth in the Foley textbook and described in Section 5 of the petition.

Tr. 9:21–10:7.

As discussed *supra* III.B, rather than specifying the same level of skill that was adopted by the District Court, Petitioner “provides specific and particular examples of the level of ordinary skill in the art as reflected by the prior art of record.” Pet. 7; *see also id.* at 7–12 (describing techniques used in rendering as described in Foley). Petitioner, however, does not explain how or why one of ordinary skill in the art would have combined those teachings with Segal’s teachings so as to remedy the aforementioned deficiencies.

“When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of

ordinary skill has good reason to pursue the known options within his or her technical grasp.” *See KSR*, 550 U.S. at 421. In the instant proceedings, we are persuaded that Petitioner does not provide arguments, explanation, or evidence that establishes in the record that the skilled artisan with the level of skill we adopt would have known how and had a reason to make the combinations and modifications of the teachings so as to arrive at the subject matter claimed.

We further note that we instituted on various grounds including Foley. Dec. on Inst. 43–44. Although Petitioner identifies portions of Foley relating to rendering a scene using conventional methods, such as conventional transformations, Petitioner does not explain persuasively how or why a person of ordinary skill in the art would have combined Foley’s teaching so as to remedy the above noted deficiencies. For instance, with respect to the steps of providing observer data, providing lighting data, and performing the comparison, Petitioner relies on only the combined and modified teachings of Segal itself. *See, e.g.*, Pet. 32–36.

We do not find contentions pertaining to the combination of Foley and Segal in either the Petition or the Reply that remedy the deficiencies discussed above. This is consistent with Petitioner’s argument during the Hearing that the Petition does not include contentions pertaining to the combination of Foley and the asserted references and Segal.

JUDGE PARVIS: Do you rely on Foley for knowledge of skill in art related to the shadow in generating this texture buffer, z-buffer?

MR. TAUB: Your Honor, not as a reference in combination, but Foley certainly informs -- and this will go to the instituted grounds and the difference at least from Petitioners’ perspective from a ground explicitly instituted with Foley as a reference in combination and the grounds as contained in the original petition.

The disclosure of Foley is relevant to the combinations that are contained in the petition itself in that the knowledge of what is described in Foley, including the knowledge of how to generate shadows using a shadow map, is relevant to what a person of ordinary skill would understand from reading the Segal reference.

So although it's not a reference that is alleged in the petition to be in combination, the understanding certainly informs -- the understanding in Foley and the disclosure of Foley certainly understands -- informs what a person of ordinary skill would understand upon reading Segal. Petitioner certainly agrees that one could combine expressly Foley in order to provide further support for (A) the understanding of Segal, and also (B) the combination.

Tr. 22:3–25.

Additionally, to the extent Petitioner argues it need not provide contentions regarding how and why a person having ordinary skill in the art would have combined Foley's teachings with the teachings of the asserted reference because Foley informs what a person having ordinary skill would understand, we are not persuaded. A determination of unpatentability on a ground of obviousness must include "articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. at 418 (quoting *In re Kahn*, 441 F.3d at 988).

Accordingly, we are not persuaded that Petitioner has established that its combination would have been reached by a person having ordinary skill in the art.

*g. Segal and McReynolds*

For the second ground, the Petition relies on the teachings discussed above, as supplemented by the teachings of McReynolds. In particular, Petitioner also points to McReynolds's teaching of using a separate accumulation buffer for accumulating light. Pet. 30, 31, 51–54 (citing Ex.

1004, 6, 16, 25–27, 29, 33, 43, 45, 66; Ex. 1005 ¶¶ 168–75, 225–32). In support of its position, Petitioner submits the testimony of Mr. Goodin that McReynolds includes detailed teachings of a variety of data structures that can be used in “OpenGL” to perform accumulation. Ex. 1005 ¶¶ 174, 175 (citing Ex. 1004, 27, 43, 45). Petitioner, however, does not provide argument, explanation, or evidence relating to McReynolds in the Petition or the Reply that remedies the aforementioned deficiencies regarding Petitioner’s proposed combination of Segal’s teachings.

*h. Conclusion*

Based on the full record before us, we are not persuaded that Petitioner has established how or why a person having ordinary skill in the art would have combined or modified the teachings relied upon in Petitioner to arrive at the subject matter recited in claim 1. For the reasons given, we determine that Petitioner has not shown by a preponderance of the evidence that claim 1 would have been obvious over Segal alone or in combination with McReynolds and/or Foley.

*4. Claims 2–10 and 27–62*

Independent claims 37 and 50 are similar in scope to independent claim 1. For the reasons given *supra* III.D.3.d–h, we are not persuaded that Petitioner has established how or why a person having ordinary skill in the art would have combined or modified the teachings of the asserted art to arrive at the subject matter recited in claim 1. Petitioner argues claims 37 and 50 collectively. ’930 Pet. 52, 53; Reply 4–18. Petitioner’s contentions as to independent claim 37 are substantively the same as those presented for independent claim 1, except that Petitioner’s contentions for claim 37 are a subset of those presented for claim 1 because claim 37 does not recite “a

light accumulation buffer.” *Compare* ’930 Pet. 7–12, 18–42, *with* Pet. 7–12, 18–41; *see also* Reply 4–18 (providing the same contentions for each of the independent claims). Petitioner’s contentions for claim 37 do not remedy the aforementioned deficiencies discussed with respect to claim 1.

Claims 2–10 depend, directly or indirectly, from independent claim 1. Petitioner’s contentions regarding dependent claims 2–10 and 27–36 do not remedy the aforementioned deficiencies. Pet. 41–50; *see also* Reply 18 (arguing only further limitations recited in certain dependent claims). Claims 38–49 and 51–62 depend, directly or indirectly, from either independent claim 37 or independent claim 50. Petitioner’s contentions regarding dependent claims 38–49 and 51–62 do not remedy the aforementioned deficiencies. ’930 Pet. 42–53; *see also* Reply 18 (arguing only further limitations recited in certain dependent claims).

Accordingly, we determine that Petitioner has not shown by a preponderance of the evidence that claims 2–10 and 27–36 would have been obvious over Segal alone or in combination with McReynolds and/or Foley. We also determine that Petitioner has not shown by a preponderance of the evidence that claims 37–62 would have been obvious over Segal alone or in combination with Foley.

*E. Obviousness of Claims 11–20 over Segal and McReynolds*

Petitioner asserts that claims 11–20 are unpatentable, under 35 U.S.C. § 103, as obvious over Segal and McReynolds. Pet. 50–60.

For claim 11, Petitioner refers to its contentions regarding independent claim 1 and provides further contentions only regarding an additional recitation in the claim. Pet. 54–60. Petitioner does not remedy the deficiencies discussed with respect to claim 1 *supra* III.D.3.d–h. Claims

12–20 are similar in scope to claims 2–10. The parties argue these claims collectively. *See, e.g.*, Pet. 60; Reply 18. Accordingly, the previous discussion with respect to claims 2–10 equally applies to claims 12–20.

Accordingly, we determine that Petitioner has not shown by a preponderance of the evidence that claims 11–20 would have been obvious over Segal alone or in combination with McReynolds and/or Foley.

*F. Whether Petitioner’s Reply Exceeds Proper Scope*

Patent Owner moves to strike Petitioner’s Reply contending that “Petitioner raises multiple new arguments at a point in the trial when [Patent Owner] does not have an opportunity to meaningfully respond.” Mot. Strike 1. Patent Owner, more specifically, contends that Petitioner’s Reply improperly “for the first time, argues that the eight equations in Segal’s mathematical preliminaries section disclose a transformation allegedly meeting the ‘*comparing*’ step of the independent claims.” *Id.* at 2. Patent Owner also contends “[n]othing” in the Patent Owner’s Response or the Decision to Institute “justifies the introduction of seven new pages of arguments based on the entirety of the mathematical preliminaries section in Segal.” *Id.* at 3–4. Patent Owner, additionally, contends that Petitioner’s Reply introduces other new theories also relating to the comparison recited in the independent claims. *See, e.g., id.* at 4.

In its Opposition, Petitioner contends that it presented its transformation theory in its Petition. *See generally* Pet. Opp. To that extent, we agree with Petitioner. Indeed, we discussed Petitioner’s contentions in this regard in our Decision on Institution. *See, e.g.*, Dec. on Inst. 25 (citing ’930 Pet. 18–26, 36, 37). We, however, agree with Patent Owner that

Petitioner's discussion of Segal's Mathematical Preliminaries section is more extensive in its Reply than its Petitions.

For the reasons discussed *supra* Section III.D.3.e, we are not persuaded by Petitioner's conclusory contentions regarding the "purpose" of Segal in its Reply. Reply 9–10. As also discussed *supra* Section III.D.3.e, we do not consider Mr. Goodin's testimony that is not explained in the Petition or the Reply because arguments must not be incorporated by reference from document into another document. For these reasons, we need not make further determinations regarding Patent Owner's Motion to Strike to resolve a dispute between the parties.

Accordingly, Patent Owner's Motion to Strike is *dismissed* as moot.

*G. Protective Order*

Patent Owner filed a Motion to Seal (Paper 20, "PO Mtn. to Seal"). certain Exhibits, i.e., Exhibits 2025, 2030, 2031, 2038, and 2044–49. Patent Owner contends that because the confidential information belongs to Petitioner, Petitioner has the burden to demonstrate that the material is confidential. Subsequently, the parties met and conferred to reduce the amount of information that Petitioner contends is confidential and the parties filed a Joint Motion to Seal (Paper 23, "Jt. Mtn. to Seal").

In this Final Written Decision, we do not rely on materials identified as confidential. The parties are reminded that these documents ordinarily will become public. *See* Office Patent Trial Practice Guide, 77 Fed. Reg. at 48,761 ("Confidential information that is subject to a protective order ordinarily [will] become public . . . after final judgment in a trial."). Pursuant to 37 C.F.R. § 42.56, Petitioner may file a motion to expunge any

above-identified confidential documents, within one week of the date of this Decision.

Accordingly, Patent Owner's Motion to Seal (Paper 20) and the parties Joint Motion to Seal (Paper 23) are *dismissed* as moot.

#### IV. CONCLUSION

Petitioner has not demonstrated by a preponderance of the evidence that claims 1–10 and 27–62 of the '488 patent are unpatentable, under 35 U.S.C. § 103, over Segal alone or in combination with Foley. Additionally, Petitioner has not demonstrated by a preponderance of the evidence that claims 1–20 and 27–36 of the '488 patent are unpatentable, under 35 U.S.C. § 103, over either the combination of Segal and McReynolds or the combination of Segal, McReynolds, and Foley.

#### V. ORDER

Accordingly, it is:

ORDERED that, Patent Owner's Motion to Strike (Paper 40) is *dismissed* as moot;

FURTHER ORDERED that claims 1–20 and 27–62 of the '488 patent, have not been proven to be unpatentable;

FURTHER ORDERED that Patent Owner's Motion to Seal (Paper 20) and the parties Joint Motion to Seal (Paper 23) are *dismissed* as moot; and

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

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Patent 7,061,488 B2

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