

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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NABORS DRILLING TECHNOLOGIES USA, INC.,  
Petitioner,

v.

MOTIVE DRILLING TECHNOLOGIES, INC.,  
Patent Owner.

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IPR2022-00289  
Patent 10,726,506 B2

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Before KEN B. BARRETT, MATTHEW S. MEYERS, and  
SEAN P. O'HANLON, *Administrative Patent Judges*.

BARRETT, *Administrative Patent Judge*.

JUDGMENT  
Final Written Decision  
Determining All Challenged Claims Unpatentable  
*35 U.S.C. § 318(a)*  
Dismissing Patent Owner's Motion to Exclude  
*37 C.F.R. § 42.64*

## I. INTRODUCTION

### A. *Background and Summary*

Nabors Drilling Technologies USA, Inc. (“Petitioner”)<sup>1</sup> filed a Petition requesting *inter partes* review of U.S. Patent No. 10,726,506 B2 (“the ’506 patent,” Ex. 1001). Paper 3 (“Pet.”). The Petition challenges the patentability of claims 1–6, 9, and 10 of the ’506 patent. We instituted an *inter partes* review of all challenged claims on all proposed grounds of unpatentability. Paper 12. Motive Drilling Technologies, Inc. (“Patent Owner”)<sup>2</sup> filed a Response to the Petition. Paper 17 (“PO Resp.”). Petitioner filed a Reply (Paper 21, “Pet. Reply”) and Patent Owner filed a Sur-reply (Paper 26, “PO Sur-reply”).

Additionally, Petitioner filed a Motion to Exclude Evidence (Paper 27), to which Patent Owner filed an Opposition (Paper 28), and Petitioner filed a Reply (Paper 29).

An oral hearing was held on April 20, 2023, and a transcript of the hearing is included in the record. Paper 32 (“Tr.”).

This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). For the reasons discussed below, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–6, 9, and 10 of the ’506 patent are unpatentable. We also *dismiss* Petitioner’s Motion to Exclude.

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<sup>1</sup> Petitioner identifies Nabors Drilling Technologies USA, Inc. and Nabors Corporate Services, Inc. as real parties-in-interest. Pet. 1.

<sup>2</sup> Patent Owner identifies Motive Drilling Technologies, Inc., Helmerich & Payne International Drilling Co., Helmerich & Payne Technologies, LLC, and Helmerich & Payne, Inc. as real parties-in-interest. Paper 5, 2.

*B. Related Proceedings*

Both parties identify, as a matter involving or related to the '506 patent, *Nabors Drilling Techs. USA, Inc. v. Helmerich & Payne International Drilling Co.*, No. 3:20-cv-03126 (N.D. Tex.). Pet. 1; Paper 5, 2.

We also note that the application that issued as the '506 patent is a continuation of the application that issued as U.S. Patent No. 9,865,022 B2, which is the subject of IPR2022-00288. *See* Ex. 1001, code (63).

*C. The '506 Patent*

The '506 patent is titled "System for Drilling a Selected Convergence Path." Ex. 1001, code (54). The '506 patent explains that "[d]rilling a borehole for the extraction of minerals has become an increasingly complicated operation due to the increased depth and complexity of many boreholes, including the complexity added by directional drilling." *Id.* at 1:23–26. "Drilling is an expensive operation and errors in drilling add to the cost and, in some cases, drilling errors may permanently lower the output of a well for years into the future." *Id.* at 1:26–29. According to the '506 patent,

Calculating paths for a borehole in a formation is a complex and often difficult to understand process that frequently uses a combination of known factors and estimates. Whether calculating the path prior to the beginning of drilling or attempting to return to a desired path when drilling has gone off course, there are an infinite number of paths from which to choose. Each of these paths has an associated financial cost that is difficult to identify due to the number of factors

involved. However, the financial cost of a path is important to the business of drilling and needs to be taken into account.

*Id.* at 2:13–23. The '506 patent further explains that, by normalizing drilling variables, multiple path options can be evaluated and the path that best satisfies one or more defined parameters can be selected. *Id.* at 2:23–28.

Figure 1 is reproduced below.

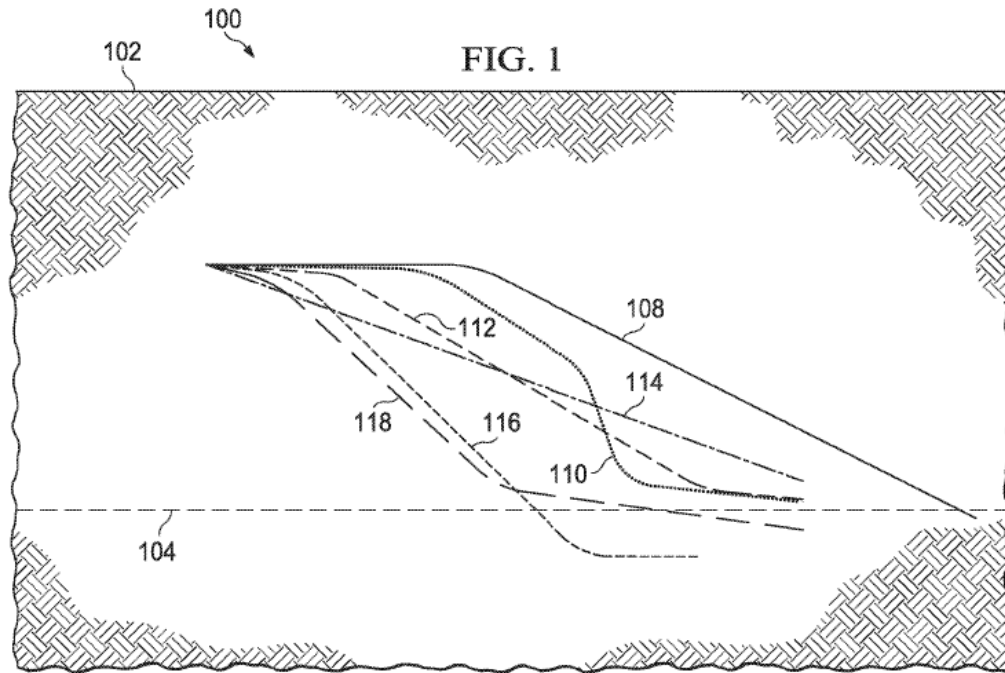


Figure 1 depicts an environment including formation 102 within which a borehole is to be or is being drilled. *See id.* at 1:39–41, 2:10–13. Target path 104 represents an optimal path for the borehole, and “paths 108, 110, 112, 114, 116, and 118 illustrate possible convergence paths from a point . . . representing a current or future bottom hole assembly (BHA) location to the target path 104.” *See id.* at 2:29–31, 2:50–53.

Figure 4 is reproduced below.

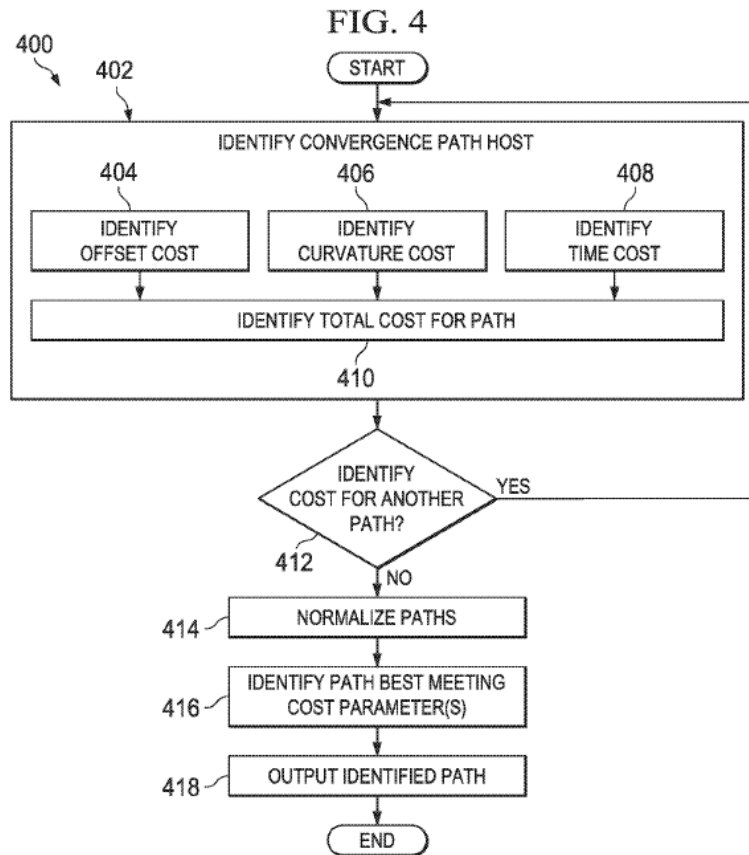


Figure 4 “illustrates a process that may be used to identify the cost of multiple convergence paths and then select one of the paths.” *Id.* at 7:1–3. As can be seen in the figure, the total cost of a path is based on the offset cost, the curvature cost, and the time cost. *See id.* at 7:7–10.

Figure 5A is reproduced below.

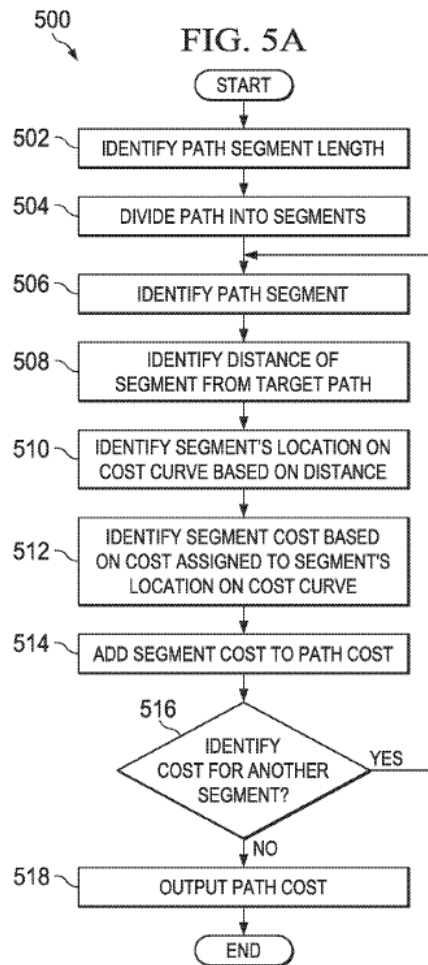


Figure 5A depicts a flowchart that is used to identify the offset cost of a convergence path, and may be used as step 404 in the flowchart of Figure 4. *Id.* at 1:52–54, 1:59–61. In step 504, the path is divided into segments of an identified length, and the length may be defined in different ways including inches, centimeters, yards, or meters. *Id.* at 8:64–9:5. As an example, a four hundred foot path would be divided into four hundred segments that each are one foot long. *Id.* at 9:5–7. In step 508, a specific segment's distance from the target path is identified. *Id.* at 9:11–12. A cost is identified for that segment and added to the path cost. *See id.* at Fig. 5A, Steps 510, 512,

and 514. The process is repeated for all segments and a path cost is output.  
*See id.* at 10:43–49.

Figure 6 is reproduced below.

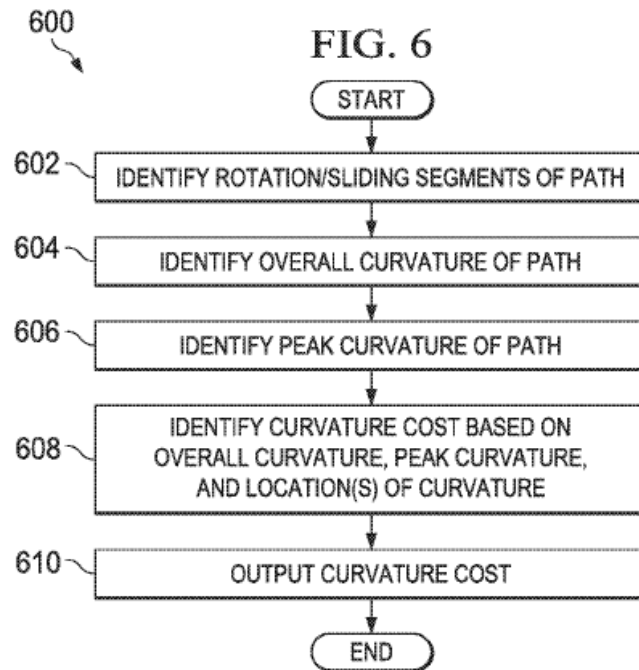


Figure 6 depicts a flow chart that is used to identify the curvature cost of a convergence path, and may be used as step 406 in the flowchart of Figure 4. *Id.* at 1:49–51, 10:50–53. “In step 604, the overall curvature of the path is identified.” *Id.* at 11:25–26.

In step 606, the peak curvature of the path is identified. The peak curvature is identified using a defined window (e.g., a window spanning a defined number of feet) to identify dogleg severity. As this window is moved along the path, the peak curvature is located and generally occurs when the entire window contains a slide or when the window overlaps multiple slides. It is understood that the distance defined for the window may greatly impact the identified peak curvature. For example, assume there is a five degree curve that occurs within ten feet and there is not another curve within one hundred feet. Using a sliding window spanning one hundred feet will result in a dogleg severity of 5°/100 ft. Using a sliding window spanning

ten feet will result in a dogleg severity of 5°/10 ft, which appears to be a much more severe dogleg even though it is actually the same one. The peak curvature, which may be less than the threshold for dogleg severity as applied by the rules in step 308 of FIG. 3, may be identified to determine cost because the greater the peak curvature, the greater the impact on later portions of the path.

*Id.* at 11:27–46. “In step 608, a curvature cost for the path is identified based on the overall (e.g., average) curvature, peak curvature, and location(s) of curvature.” *Id.* at 11:57–59.

#### *D. Illustrative Claim*

Of the challenged claims of the '506 patent, claim 1 is an independent claim. Each of challenged claims 2–6, 9, and 10 depends directly from independent claim 1. Claim 1, reproduced below with paragraphing and Petitioner's bracketed annotations inserted, is illustrative.

1. [1.0] A drilling system comprising:
  - [1.1] a drilling system having a drill string and a bottom hole assembly at one end of the drill string;
  - [1.2] a computer system coupled to said drilling system, said computer system comprising at least one processor and at least one memory unit, wherein
    - [1.3] the at least one memory unit is coupled to the at least one processor and configured to store a plurality of instructions executable by the at least one processor,
    - [1.4] the instructions including instructions for:
      - [1.5] (i) identifying a plurality of convergence paths, wherein each of the convergence paths provides a convergence

solution from a bottom hole assembly (BHA) location to a target path for a bore hole;

[1.6] (ii) calculating an offset distance for drilling by the BHA each of the convergence paths to the target path;

[1.7] (iii) identifying a drill path curvature of each convergence path;

[1.8] (iv) identifying an amount of time needed to drill each convergence path;

[1.9] (v) selecting one of the convergence paths as an optimal convergence path based on at least one of the offset distance, the drill path curvature, and the amount of time needed to drill the convergence paths; and

[1.10] (vi) controlling the drilling system to drill in accordance with the selected convergence path.

Ex. 1001, 13:6–29.

*E. Evidence*

Petitioner relies on the following references:

| Name      | Reference                                                                                               | Exhibit(s) |
|-----------|---------------------------------------------------------------------------------------------------------|------------|
| Budiman   | US 8,892,407 B2; PCT Filed July 2, 2009; National Stage Appl. filed Jan. 10, 2011; Issued Nov. 18, 2014 | 1005       |
| Pirovolou | US 2010/0185395 A1; Filed Jan. 22, 2009; Published July 22, 2010                                        | 1006       |
| Schottle  | US 2006/0247903 A1; Filed Apr. 29, 2005; Published Nov. 2, 2006                                         | 1008       |
| Johnston  | US 2010/0282508 A1; Filed Apr. 30, 2010; Published Nov. 11, 2010                                        | 1010       |
| Boone     | US 2009/0090555 A1; Filed Sept. 19, 2008; Published Apr. 9, 2009                                        | 1019       |
| Downton   | US 2011/0031015 A1; Filed Aug. 5, 2009; Published Feb. 10, 2011                                         | 1023       |
| Alft      | US 6,749,029 B2; Filed Apr. 8, 2003; Issued June 15, 2004                                               | 1025       |

Petitioner also relies on the declaration of Dr. Jerome J. Schubert (Ex. 1003) in support of its arguments, and Patent Owner relies on the

declaration of Dr. L. Brun Hilbert, Jr. (Ex. 2010) in support of its arguments. The parties also rely on other exhibits as discussed below.

*F. Asserted Grounds of Unpatentability*

Petitioner asserts that the challenged claims are unpatentable on the following grounds:

| <b>Claim(s) Challenged</b> | <b>35 U.S.C. §</b> | <b>Reference(s)/Basis</b>                              |
|----------------------------|--------------------|--------------------------------------------------------|
| 1, 5, 9                    | 103                | Pirovolou, Budiman                                     |
| 2, 5, 6                    | 103                | Pirovolou, Budiman, Schottle                           |
| 10                         | 103                | Pirovolou, Budiman, Alft                               |
| 4                          | 103                | Pirovolou, Budiman, Johnston                           |
| 3                          | 103                | Pirovolou, Budiman, Schottle, Johnston, Boone, Downton |

**II. ANALYSIS**

*A. Principles of Law*

Petitioner bears the burden of persuasion to prove unpatentability of the claims challenged in the Petition, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must establish by a preponderance of the evidence that the challenged claims are unpatentable. 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2021).

A patent claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art;

(2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) if present, any objective evidence of obviousness or non-obviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

*B. The Level of Ordinary Skill in the Art*

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995).

Petitioner contends that:

A person of ordinary skill in the art (“POSITA”) at the priority date of the ’506 Patent would have had (i) a bachelor’s degree in mechanical engineering or petroleum engineering, or equivalent training, and (ii) 3–5 years of work experience related to the design, performance, and control of components and systems used in oil and gas exploration and production, including downhole tools used in drilling applications. A lack of experience can be remedied with additional education, and vice versa.

Pet. 8 (citing Ex. 1003 ¶¶ 36–40). Patent Owner’s declarant, Dr. Hilbert, affirmatively states agreement with Petitioner’s description. Ex. 2010 ¶ 49.

We determine that the definition offered by Petitioner comports with the qualifications a person would have needed to understand and implement the teachings of the ’506 patent and the prior art of record. *Cf. Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (the prior art itself may reflect an appropriate level of skill in the art). We apply Petitioner’s description of the person of ordinary skill in the art.

### *C. Claim Construction*

We apply the same claim construction standard used in district court actions under 35 U.S.C. § 282(b), namely that articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). See 37 C.F.R. § 42.100(b) (2021). In applying that standard, claim terms generally are given their ordinary and customary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips*, 415 F.3d at 1312–13. “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17).

The parties propose constructions for the claim terms “offset distance” and “drill path curvature.” PO Resp. 12–25; Pet. Reply 1–13; PO Sur-reply 1–13. In the related litigation, the District Court issued a claim construction order regarding the ’506 patent. Ex. 2012. The District Court did not address these two terms. See *id.* at 35–37.

#### *1. Offset Distance*

Independent claim 1, specifically limitation 1.6, recites: “calculating an *offset distance* for drilling by the BHA each of the convergence paths to the target path.” Ex. 1001, 13:19–21 (emphasis added).

The parties agree that an “offset distance” means an offset distance of a convergence path relative to the target path. PO Resp. 12–13; Pet. Reply 1; PO Sur-reply 2. The parties also agree that the claims are not limited to one offset distance value for a given convergence path and that the offset distance between a convergence path and a target path can be different

at different points on the two paths. *See* Pet. Reply 3, 8; PO Sur-reply 2–3 (Patent Owner asserting that it is not applying the term “such that each path respectively has only one offset distance to the target path” (emphasis omitted)); *id.* at 4 (“[Patent Owner] does not dispute that ‘an’ in ‘an offset distance’ carries the meaning of ‘one or more’ in the context of limitation 1.6.”).

The parties’ agreed-upon construction of “offset distance” is consistent with the Specification of the ’506 patent. For example, the Specification describes a method where a convergence path is divided into segments of, e.g., one foot in length and, in Step 508, each “segment’s distance from the target path is identified.” Ex. 1001, 8:61–9:12, Fig. 5. We adopt the parties’ agreed-upon construction of “offset distance.”

## 2. *A Drill Path Curvature*

Independent claim 1, specifically limitation 1.7, recites: “identifying *a drill path curvature* of each convergence path.” Ex. 1001, 13:21–22 (emphasis added).

Petitioner contends that “a drill path curvature” has its plain and ordinary meaning (Pet. 9) and that the phrase is “broad enough to include *all* types of curvature” (Pet. Reply 12). In the context of its obviousness challenges, Petitioner contends that a dog-leg severity is “a drill path curvature” within the meaning of the challenged patent. Pet. 37.

Patent Owner contends that “a drill path curvature” means “an overall curvature of a given convergence path.” PO Resp. 17. According to Patent Owner, this proposed construction is consistent with the ordinary meaning that the phrase would have had to a person of ordinary skill in the art. *Id.* Patent Owner implicitly argues that each convergence path has a *single* “drill path curvature” within the meaning of the ’506 patent, and further argues

that a person of ordinary skill in the art “would have understood that the claimed ‘drill path curvature’ is the curvature of the convergence path as a whole, and not, for example, the dog-leg severity of a given turn.” *Id.* at 20–21 (citing Ex. 2010 ¶ 62).

For the reasons discussed below, we determine that Petitioner has the better position and that the recitation of “a drill path curvature” covers any type of curvature and is not limited to the specific “overall” curvature, as advocated by Patent Owner.

We first look to the claim language itself. The phrase “a drill path curvature” does not contain the limiting modifier “overall” proposed by Patent Owner, and Patent Owner has not adequately explained why we should read that word into the claim.

As an initial matter, we note that Patent Owner and Dr. Hilbert repeatedly refer to “*the* ‘drill path curvature.’” *See, e.g.*, PO Resp. 22, 24 (emphasis added); Ex. 2010 ¶¶ 63–64, 66. For example, Patent Owner refers to “*the* ‘drill path curvature’ recited in Claim 1.” PO Resp. 23 (emphasis added). Patent Owner’s use, in its arguments, of the definite article “the” implies that the claim recites a singular curvature. *See Superior Fireplace Co. v. Majestic Prods. Co.*, 270 F.3d 1358, 1373 (Fed. Cir. 2001) (The limitation “‘the rear wall of the firebox’ . . . refers to rear wall in the singular, with the definite article ‘the.’”). Such a singular recitation would be consistent with Patent Owner’s proposed construction. *See, e.g.*, PO Resp. 22 (“A POSITA would have understood that *the* ‘drill path’ is the entire convergence path and *the* “drill path curvature” is the overall curvature of the convergence path, not simply the dogleg severity.” (emphasis added)); *id.* at 18 (“The words ‘drill path’ limit the determined

curvature to a specific type—the curvature of the ‘drill path’ (i.e., the curvature of the convergence path).”). However, the independent claim actually recites “a drill path curvature.” Ex. 1001, 13:21. As a general rule, the word “a” in a claim signifies one or more. *01 Communique Lab., Inc. v. LogMeIn, Inc.*, 687 F.3d 1292, 1297 (Fed. Cir. 2012). “The exceptions to this rule are extremely limited: a patentee must evince a clear intent to limit ‘a’ or ‘an’ to ‘one.’” *Id.* (quoting *Baldwin Graphic Sys., Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1342 (Fed. Cir. 2008) (internal quotation marks omitted)). We perceive no such clear intent to deviate from this general rule.<sup>3</sup>

According to Patent Owner, its proposed constructions are “the ordinary meaning that a [person of ordinary skill in the art] would have attributed to certain claim elements in light of the intrinsic record of the ’506 Patent.” PO Resp. 11–12. Patent Owner asserts that the phrase “drill path” limits the recited curvature to a specific type (*id.* at 18 (citing Ex. 2010 ¶ 60)), and that a person of ordinary skill in the art “would have understood the ordinary meaning of ‘drill path curvature’ in limitation 1.7 to mean a curvature of the convergence path as a whole (i.e., the ‘overall’ curvature of the convergence path)” (*id.* at 19 (citing Ex. 2010 ¶ 61)). For this proposition concerning ordinary meaning, Patent Owner relies on

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<sup>3</sup> The recitation, later in the claims, of “the drill path curvature” does not change the outcome as that recitation is referring back to the same non-singular claim term. *See* Ex. 1001, 13:23–26 (“selecting one of the convergence paths as an optimal convergence path based on at least one of . . . the drill path curvature”); *01 Communique Lab., Inc.*, 687 F.3d at 1297 (“The subsequent use of definite articles ‘the’ or ‘said’ in a claim to refer back to the same claim term does not change the general plural rule, but simply reinvokes that non-singular meaning.” (internal quotation marks omitted)).

Dr. Hilbert’s testimony, which repeats, almost verbatim, Patent Owner’s arguments and without supporting evidence. *Compare id.* at 17–19, with Ex. 2010 ¶¶ 60–61. Neither Patent Owner nor Dr. Hilbert points to any persuasive evidence showing that a person of ordinary skill would have understood the term “overall” to be the ordinary meaning of “drill path.”

Patent Owner argues that, if any type of curvature (as opposed to Patent Owner’s specific type of “overall curvature”) satisfies the requirement of “a drill path curvature,” “the words ‘drill path’ would be rendered superfluous.” PO Resp. 18 (citing *Power Mosfet Techs., L.L.C. v. Siemens AG*, 378 F.3d 1396, 1410 (Fed. Cir. 2004) (“[I]nterpretations that render some portion of the claim language superfluous are disfavored.”)); *see also* PO Sur-reply 5 (arguing that “a curvature” other than the “specific type,” “the ‘overall’ curvature,” renders the words “drill path” superfluous).

Petitioner replies that dependent claim 10 recites “a peak drill path curvature” and contends that “[t]his confirms ‘drill path’ doesn’t mean ‘overall’ but merely describes the type of curvature, i.e., of a drill path, as opposed to something else (e.g., of a formation).” Pet. Reply 9. We find Petitioner’s position more persuasive and we disagree with Patent Owner’s argument as we are not persuaded that Petitioner’s proposed construction renders “drill path” superfluous. *See also* Ex. 1001, 11:25–27 (the Specification indicating the drafter used “of the path” to clearly indicate the subject of a given type of curvature (overall and peak)); Ex. 2010 ¶ 61 (“[T]he claim language ‘drill path curvature’ is just another way of saying curvature *of the path*.”). We agree with Petitioner that “drill path” is not rendered superfluous if it is not construed as synonymous with “overall.” Additionally, the preference against superfluous claim language is not a rigid

rule that would justify, in this case, reading “overall” into the claim and thus narrowing the subject limitation to only one specific type of “curvature.”

*SimpleAir, Inc. v. Sony Ericsson Mobile Commc’ns AB*, 820 F.3d 419, 429 (Fed. Cir. 2016) (“The preference for giving meaning to all terms . . . is not an inflexible rule that supersedes all other principles of claim construction.”).

The Specification uses the term “overall” as one modifier of “curvature,” indicating that the drafter knew how to use the term “overall” to specify a particular curvature parameter when intended and to distinguish from another curvature parameter, for example, peak curvature. *See* Ex. 1001, 11:25–27 (“In step 604, the overall curvature of the path is identified” and, “[i]n step 606, the peak curvature of the path is identified.”), 11:57–59 (“In step 608 [of Figure 6], a curvature cost for the path is identified based on the *overall (e.g., average) curvature, peak curvature*, and location(s) of curvature.” (emphasis added)), Fig. 6 (“overall curvature of path,” “peak curvature of path”). Patent Owner does not explain adequately why the drafter would omit the word “overall” in the claim if “overall curvature” was intended. Rather, the absence of such a limiting modifier in the independent claims suggests that the drafter sought broad coverage that is not limited to any specific type of a curvature.

Patent Owner points to the Specification’s description of Figure 1 as showing various alternative paths “each with different curvature.” PO Resp. 20 (quoting Ex. 1001, 3:12–16) (emphasis omitted). According to Patent Owner, “[b]ased on the specification’s description that each of the convergence *paths* has a different curvature, a POSITA would have understood that the claimed ‘drill path curvature’ is the curvature of the

convergence path as a whole, and not, for example, the dog-leg severity of a given turn.” *Id.* at 20–21 (citing Ex. 2010 ¶ 62). We do not find this argument persuasive. When read in the overall context of the Specification, the unmodified term “curvature” is a broad genus encompassing species such as “overall curvature” and “peak curvature.” *Cf.* Tr. 44:16–18 (Patent Owner’s counsel referring to a demonstrative exhibit reproducing the above-quoted “different curvature” disclosure and characterizing the Specification as explaining that each alternative path has “different curvature considerations that affect the cost of that particular path.”).

Patent Owner argues that “the specification [of the ’506 patent] repeatedly distinguishes between dog-leg severity and ‘overall curvature.’” PO Sur-reply 12; *see also, e.g.*, PO Resp. 20–24. We do not find this assertion to be helpful in our claim construction analysis. As Petitioner notes, neither term is used in the subject claim phrase being construed, “a drill path curvature.” *See* Pet. Reply 12. Patent Owner is, in effect, arguing that a prior art reference’s disclosure of a dog-leg severity does not read on the claim under Patent Owner’s proposed construction. Even if true, that does not support a conclusion that Patent Owner’s proposed construction is correct. *Cf. TI Grp. Auto. Sys. (N. Am.), Inc. v. VDO N. Am., L.L.C.*, 375 F.3d 1126, 1139 (Fed. Cir. 2004) (“Our [patentability] analysis is a two-step procedure: The first step involves the proper interpretation of the claims. The second step involves determining whether the limitations of the claims as properly interpreted are met by the prior art.” (internal quotation marks omitted)).

Relatedly, Patent Owner argues that the Specification “distinguishes between a path’s ‘curvature cost’ and ‘dogleg cost’” through the appearance

of both of those terms in the same sentence as examples of different types of costs. PO Resp. 22–23 (quoting Ex. 1001, 3:32–36). We also do not find this helpful to our analysis as the pertinent claim term is not a “cost.” Additionally, the Specification indicates that “curvature cost” is determined after the identification of plural types of curvature including overall and peak, thus contradicting Patent Owner’s implied argument that “curvature cost” refers to the cost due only to the “overall curvature.” *See, e.g.*, Ex. 1001, Fig. 6.

Petitioner points to two patents in the continuity chain of the ’506 patent, one before and one after, that use the term “overall” to modify “curvature” in claims and to distinguish overall curvature from another specific type of curvature. *See* Pet. Reply 8 (citing Ex. 1032 (U.S. Patent No. 8,996,396 B2), claims 5, 19, 27; Ex. 1033 (US 11,170,454 B2), claims 5, 14, 20); *see also* Ex. 1033, 1:4–29 (listing related applications and patents in the continuity chain including Application Ser. No. 15/836,563, which issued as the ’506 patent); *E.I. du Pont De Nemours & Co. v. Unifrax I LLC*, 921 F.3d 1060, 1069–71 (Fed. Cir. 2019) (a patent with a familial relationship to the challenged patent may be treated as intrinsic evidence in certain circumstances, for example, where there is common subject matter). These patents, having the same three named-inventors as the ’506 patent, are evidence that the drafter knew how to use the term “overall” when the claimed subject matter is intended to be narrowly claimed. *But see* PO Sur-reply 6–7 (Patent Owner arguing that “the claims in U.S. 8,996,396 . . . relate to identifying or calculating ‘a curvature *cost*’ of a path,” and therefore do not undercut its position that “drill path curvature” means “overall curvature”). Claim 5 of U.S. Patent No. 8,996,396 B2, for

example, recites “identifying *a peak curvature of the geometric convergence path*,” “identifying *an overall curvature of the geometric convergence path*,” and “identifying the curvature cost responsive to the peak curvature and the overall curvature.” Ex. 1032, 13:44–47 (emphasis added). As another example, the recitation in claim 5 of U.S. Patent No. 11,170,454 B2 (“the ’454 patent”) that “the curvature associated with each of the possible convergence paths comprises an overall curvature, a peak curvature, a location, or a combination thereof” is consistent with our determination above that the term “curvature” is a broad term that may encompass the different types and is not necessarily coterminous with “overall curvature,” as Patent Owner appears to argue. Ex. 1033, 14:3–7; *but see* PO Sur-reply 6 (Patent Owner arguing that, “[a]t most, the ’454 Patent’s claims demonstrate that ‘a curvature’ is broader than ‘a drill path curvature’ as claimed in the ’506 Patent.” (emphasis omitted)).

Turning to the extrinsic evidence, we first address Patent Owner’s argument that Dr. Schubert agreed that Patent Owner’s proposed construction is correct. *See, e.g.*, PO Resp. 17–18; PO Sur-reply 6. Patent Owner points to Dr. Schubert’s response of “Yes” when asked, on cross-examination, if “[a] person of skill in the art would understand that a drill path curvature refers to the path’s curvature.” PO Resp. 18 (quoting Ex. 2011, 42:13–16). This exchange does not support Patent Owner’s position. Neither the question nor the response contains the word “overall” that Patent Owner includes in its proposed construction, and the testimony does not, as Patent Owner asserts, agree that “[t]he words ‘drill path’ [in the claims] limit the determined curvature to a specific type.” *Id.*; *see also id.* at 19 (quoting Ex. 2011, 39:23–40:1 (Dr. Schubert unremarkably agreeing

that “another way of saying curvature of the path would be drill path curvature”)).

As mentioned, Dr. Hilbert repeatedly refer to “*the* ‘drill path curvature,’” whereas the claim recites “*a* drill path curvature.” *See* Ex. 2010 ¶¶ 63–64, 66 (emphasis added). This suggests that Dr. Hilbert started with the assumption that the claim recites a single curvature for the drill path, thus leading to his conclusion that the claim is referring to a specific type, namely the “overall curvature.” *See, e.g., id.* ¶ 64 (“Based on the specification, in my opinion a POSITA would have understood *the* ‘drill path curvature’ recited in Claim 1 to refer to the curvature of the entire convergence path . . . .”) (emphasis added), ¶ 63 (“A POSITA would have understood that *the* ‘drill path’ is the entire convergence path and *the* ‘drill path curvature’ is the overall curvature of the convergence path, not simply the dogleg severity.” (emphasis added)); *see also id.* ¶ 60 (concluding that “[a] POSITA would understand the words ‘drill path’ *in the claims* limit the determined curvature to a specific type—the curvature of *the* ‘drill path’ (i.e., the curvature of the convergence path).” (emphasis added)). This apparent misreading of the claim language infects all of Dr. Hilbert’s testimony regarding the meaning of “a drill path curvature.” We find Dr. Hilbert’s testimony not credible.

Patent Owner notes that “Claim 1 is concerned with selecting an optimal convergence path.” PO Resp. 18. Patent Owner, citing the testimony of both Dr. Hilbert and Dr. Schubert, asserts that “a POSITA would have understood that to select an optimal convergence path, one would want to consider the convergence path as a whole,” and, from this, argues that a person of ordinary skill would understand “drill path curvature”

to mean the overall curvature. *Id.* at 19 (citing Ex. 2010 ¶ 61; Ex. 2011, 34:14–35:3). This argument and Dr. Hilbert’s corresponding opinion is inconsistent with the intrinsic evidence. Independent claim 1 does not require the consideration of any curvature in determining an optimal convergence path, but rather recites the drill path curvature as an optional variable in the selecting step. *See* Ex. 1001, 13:23–27 (“selecting one of the convergence paths as an optimal convergence path based on *at least one of* the offset distance, the drill path curvature, and the amount of time needed to drill the convergence paths”) (emphasis added)). The difference between independent claim 1 and independent claim 13, which requires “a plurality of” the three variables in its selection, indicates that the drafter sought varying scopes of an “optimal” path. *See id.* at 14:38–42 (the selecting step of claim 13); *see also, e.g., id.* at 13:52–61 (dependent claims 7 and 8 adding further considerations to the “step [of claim 1] of selecting one of the convergence paths as an optimal convergence path”). Thus, what someone else (e.g., the person of ordinary skill) allegedly would desire in the determination of an optimal path is of little or no value in analyzing the scope of coverage defined by the challenged claims.

Having considered the parties’ arguments and evidence, we conclude that the recitation of “a drill path curvature” covers any type of curvature and is not limited to the specific “overall” curvature.

*D. The Alleged Obviousness of Claims 1, 5, and 9  
in View of Pirovolou and Budiman*

Petitioner alleges that claims 1, 5, and 9 of the ’506 patent would have been obvious over Pirovolou and Budiman. *See* Pet. 10–46 (addressing claim 1).

Independent claim 1, generally speaking, calls for a drilling system having a drill string, a bottom hole assembly, and a computer system with instructions in memory to cause a processor to calculate or identify three parameters for each of a plurality of paths from the bottom hole assembly location that converge on a target path, selecting an optimal convergence path based on at least one of those parameters, and controlling the drilling in accordance with that selected convergence path. Ex. 1001, 13:6–29. Those parameters are offset distance, drill path curvature, and time needed to drill the convergence path. *See id.*

Petitioner contends that Pirovolou discloses much of the subject matter of independent claim 1, asserting, *inter alia*, that “Pirovolou discloses determining an optimal path from many possible paths from a BHA to a target path based on various parameters related to each path.” Pet. 43. Petitioner relies on Pirovolou for disclosure of the curvature parameter. *See id.* at 36–37. Petitioner turns to Budiman for the other parameters, contending that a person of ordinary skill in the art “would have been motivated to use the additional parameters described in Budiman (offset distance and time required to drill) in Pirovolou’s optimal-path determination.” *Id.* at 44.

Patent Owner argues, *inter alia*, that Petitioner’s proposed combination fails to disclose or suggest the limitations directed to an offset distance, a drill path curvature, drilling time, and selecting an optimal convergence path based on at least one of those parameters. *See* PO Resp. 30–31 (referring to limitations 1.6, 1.7, 1.8, and 1.9).

For the reasons given below, we determine Petitioner has shown by a preponderance of the evidence that the challenged claims 1, 5, and 9 are unpatentable over Pirovolou and Budiman.

*1. Pirovolou (Ex. 1006)*

Pirovolou “relates to wellbore operations and more specifically to a method and system for altering a wellbore trajectory while drilling.”

Ex. 1006 ¶ 1. According to Pirovolou,

After [wellbore] drilling commences . . . it is often realized that the preplanned trajectory will not arrive at the desired target(s) and that the trajectory must be corrected. Alternatively, it may be determined that the desired target has changed and the trajectory should change to reach the new target. Further, it may be determined that there is an improved trajectory to reach the desired target.

*Id.* ¶ 6.

Figure 3 is reproduced below.

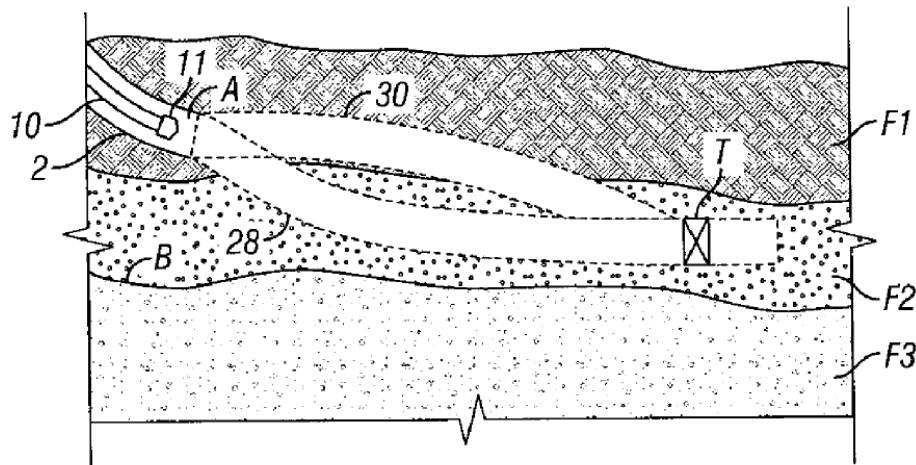


**FIG. 3**

Figure 3 is a conceptual illustration of a wellbore 2 that extends into the formation and terminates at position “A” and where the zone of interest or target is identified as point “T.” *Id.* ¶ 27. Figure 3 also depicts “two

examples of optional trajectories 28 and 30 extending from position A to target T.” *Id.* ¶ 29.

The target T may be the termination point of the wellbore 2 or a target between the current position A and the termination point of the wellbore 2. In an embodiment, the target T may be changing or moving. For example, the target T may be set a certain predetermined distance ahead of the drill bit 11. The target T may be a position on a predetermined geometric plan of the wellbore 2. The target T may also be manually selected by, for example, an operator, a geologist, an engineer or like individual related to the well system 100. The target T may be the ultimate target selected by the geologist, for example, and the methods and systems described herein may use intermediate targets, such as targets a predetermined distance ahead of the drill bit 11, to reach the ultimate target T.

*Id.* ¶ 27.

Pirovolou states that “the present invention provides a method for correcting the trajectory (or well plan) taking into consideration one or more factors,” and, as an example, “in some embodiments, the corrected trajectory is selected from one of numerous possible trajectories by assigning a cost to each possible trajectory and selecting a trajectory based on a cost function analysis.” *Id.* ¶ 28. Pirovolou further explains that, “[b]ecause there are nearly an infinite number of paths from the position A to the target T, the factors or the considerations permit a selection of one of the paths that is preferably the optimal path based on those factors or considerations.” *Id.* ¶ 29.

Possible trajectories may be selected by obtaining or inputting drilling considerations. Such as minimizing dog-leg severity, minimizing torque and drag forces to reach the target T, minimizing predicted torque and drag forces for drilling beyond the target T, such as to the termination of the wellbore or to a subsequent point or target, maximizing rate of penetration, minimizing required drilling fluid flow rate, or

other consideration related to drilling a wellbore appreciated by a person having ordinary skill in the art. The optimal trajectory may be selected from the possible trajectories by analyzing the data in view of the production considerations and/or the drilling considerations.

*Id.* ¶ 34; *see also id.* ¶ 7 (“[T]he parameters [to determine a cost function associated with each possible path] may include without limitation dog-leg severity, torque and drag, and drilling rig requirements and/or limitations.”). Controller 19 may transmit data and signals from the surface to the drill string and the bottomhole assembly (BHA), and “[t]he optimal trajectory (or well plan) may be selected by the controller 19.” *Id.* ¶¶ 21, 29.

2. *Budiman (Ex. 1005)*

Budiman “relates generally to oil and gas production, and more particularly to integrating well trajectory and well development planning processes.” Ex. 1005, 1:15–17. According to the Abstract of Budiman, it describes “[a] robust well trajectory planning and drilling or completion planning system that integrates well trajectory optimization and well development planning optimization so that optimized solutions are generated simultaneously.” *Id.* at code (57). Budiman describes a design phase in which candidate well path parameters are provided for each segment of each well and the parameters are adjusted to achieve an optimal solution. *Id.* at 5:58–6:2.

Figure 1B is reproduced below.

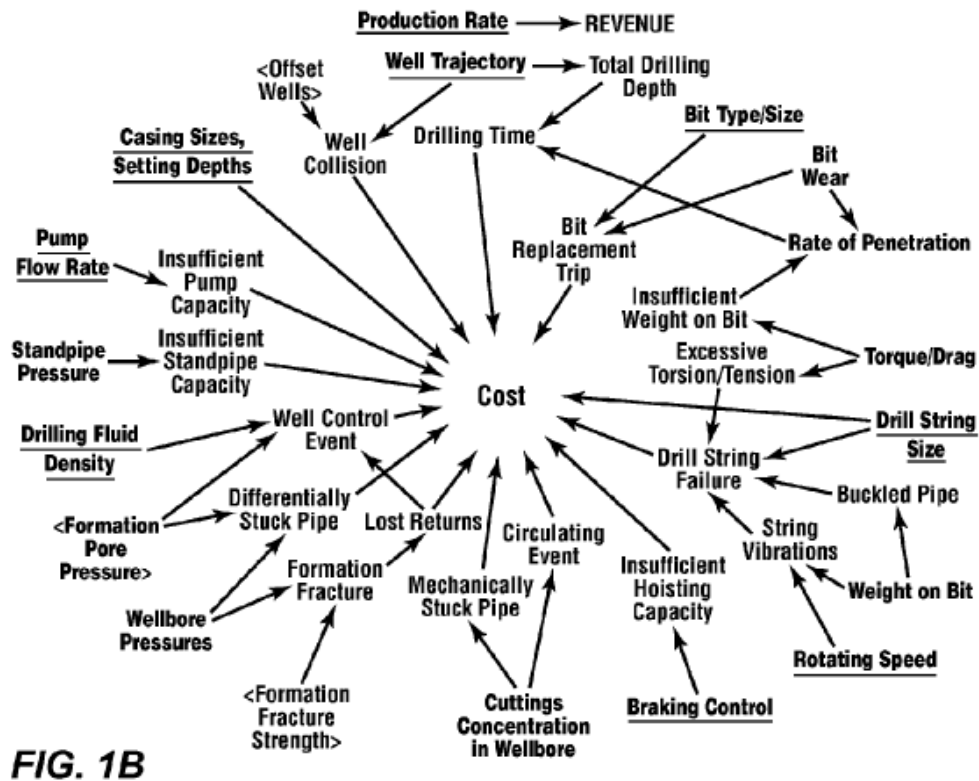


Figure 1B, above, “illustrates a continuation of the drilling influence diagram [of Figure 1A] depicting undesirable consequences associated with exceeding certain drilling limits and costs associated with those consequences, as well as costs associated with normal drilling activities, in accordance with certain exemplary embodiments of the present invention.”  
*Id.* at 4:19–24.

Figure 3 is reproduced below.

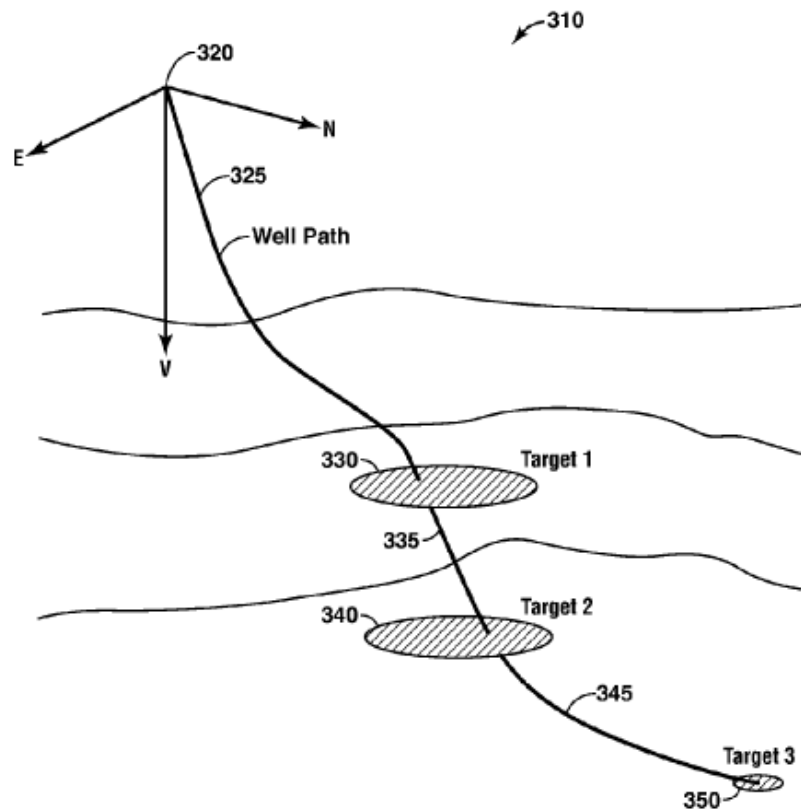


**FIG. 3**

Figure 3 illustrates a well path proceeding through multiple geological targets. *Id.* at 4:29–31.

The well path 310 is shown to proceed from a first location 320 to a target 1 330, further proceeding to a target 2 340, and further proceeding to a target 3 350. The well path 310 consists of multiple discretized segments 325, 335, 345, wherein each discretized segment 325, 335, 345 connects two consecutive geologic targets.

*Id.* at 13:9–16. “[E]ach discretized segment 325, 335, 345 consists of a series of five sub-segments.” *Id.* at 13:20–21.

Budiman explains that “[t]he optimization problem is posed as one that minimizes the length of the well path.” *Id.* at 14:9–10. “In addition to minimizing length, deviation from geologic targets is also minimized.” *Id.*

at 14:10–11. “[D]eviation from targets” also appears in dependent claims 19 and 20.

19. The method of claim 1, wherein the objective function is additionally optimized to minimize at least one of cost, well path deviation from targets, or time, subject to satisfying constraints on the drilling.

20. The method of claim 1, wherein the objective function is additionally optimized to minimize well path deviation from targets, subject to satisfying constraints on the drilling.

*Id.* at 20:4–10.

3. *The Alleged Obviousness of Independent Claim 1 in View of Pirovolou and Budiman*

Petitioner contends that the combination of Pirovolou and Budiman teaches each limitation of independent claim 1 and that a person of ordinary skill in the art would have been motivated to make the proposed combination. Pet. 15–46.

a. *[1.0] A drilling system comprising:*

*[1.1] a drilling system having a drill string and a bottom hole assembly at one end of the drill string;*

*[1.2] a computer system coupled to said drilling system, said computer system comprising at least one processor and at least one memory unit, wherein*

*[1.3] the at least one memory unit is coupled to the at least one processor and configured to store a plurality of instructions executable by the at least one processor,*

Petitioner contends that, “[t]o the extent the preamble is limiting, it is disclosed by Pirovolou,” and, asserts that Pirovolou’s Figure 1 shows a drilling system. Pet. 15–17 (citing Ex. 1003 ¶¶ 82–85; Ex. 1006 ¶¶ 6, 15–21).

For limitation [1.1], Petitioner contends that “Pirovolou’s drilling system includes a ‘drill string 4’ that is ‘suspended within the wellbore 2 and has a bottomhole assembly 10 which includes a drill bit 11 at its lower end’ (a drilling system having a drill string and a bottom hole assembly).” *Id.* at 17 (emphasis omitted) (citing Ex. 1006 ¶ 16, Fig. 1).

For limitations [1.2] and [1.3], Petitioner contends that Pirovolou discloses, as part of the drilling system, controller 19 (also identified as control system 19) and that control system 19 may be a computer-based system. *See id.* at 19–20 (citing, *inter alia*, Ex. 1006 ¶ 22, Fig. 1). Petitioner further contends that Pirovolou discloses that controller/control system 19 may have central processing unit (CPU) 20 coupled to memory 22 and that executable software or instructions are stored on a database. *See id.* at 20–24 (citing, *inter alia*, Ex. 1006 ¶ 22, Fig. 2). Petitioner additionally contends that a person of ordinary skill in the art “would have understood that Pirovolou’s reference to ‘stor[ing]’ instructions or software ‘on a database’ refers to storing information in the memory coupled to the CPU.” *Id.* at 24 (alteration in original) (citing Ex. 1006 ¶ 22, Fig. 2; Ex. 1003 ¶ 97).

Patent Owner does not raise any arguments regarding the preamble and limitations [1.1] through [1.3] of claim 1.

We find that, based on the arguments and evidence presented by Petitioner, that Pirovolou discloses or suggests the preamble and these limitations.

*b. [1.4] the instructions including instructions for:*

This recitation of “the instructions including instructions for” precedes a list of six actions that are the subject of the recited “instructions” and that constitute limitations [1.5] through [1.10]. *See* Ex. 1001, 13:12–29. Petitioner contends that Pirovolou discloses a computer system with

instructions and that the Pirovolou and Budiman individually or in combination discloses or renders obvious each of the actions recited in limitations [1.5] through [1.10]. Pet. 24–25. Those limitations are discussed below.

Patent Owner disputes Petitioner’s contentions regarding some of those limitations, as discussed below, but does not raise any arguments regarding this “instructions including instructions for” limitation [1.4] of claim 1.

We find that, based on the arguments and evidence presented by Petitioner, that Pirovolou discloses or suggests the “instructions” limitation.

*c. [1.5] (i) identifying a plurality of convergence paths, wherein each of the convergence paths provides a convergence solution from a bottom hole assembly (BHA) location to a target path for a bore hole;*

Petitioner contends that Pirovolou discloses or suggests this limitation. Pet. 25–31. Petitioner asserts that “Pirovolou discloses or renders obvious Limitation [1.5] because it describes computer software that identifies various possible trajectories from the position of a BHA to a target path.” *Id.* at 25 (citing Ex. 1003 ¶ 100). Petitioner contends that the optional trajectories 28 and 30 shown in Pirovolou’s Figure 3 correspond to the recited convergence paths. *See, e.g., id.* at 25–27. Petitioner further contends that Pirovolou’s discussion of a predetermined geometric plan of the wellbore, along which the target T may be positioned, is a disclosure of the recited target path. *See, e.g., id.* at 26. Patent Owner does not raise any arguments regarding this limitation of claim 1.

Pirovolou discloses, *inter alia*, that “a method is provided that may be utilized to correct or provide a trajectory from the position A to the target T” and that Figure 3 “illustrates . . . two examples of optional trajectories 28

and 30 extending from position A to target T.” Ex. 1006 ¶¶ 28, 29; *see also id.* ¶ 23 (“[O]ne of ordinary skill in the art will appreciate that the methods and systems described may be applied to predetermined plans, such as to return the drill bit 11 to the predetermined plan.”). We find that, based on the arguments and evidence presented by Petitioner and for reasons discussed further below in the context of limitation 1.6, Pirovolou teaches or suggests the recited step of identifying a plurality of convergence paths.

*d. [1.6] (ii) calculating an offset distance for drilling by the BHA each of the convergence paths to the target path;*

Petitioner contends that the combination of Pirovolou and Budiman discloses or suggests this “offset distance” limitation. Pet. 31–36.

As indicated in limitation 1.5 (discussed immediately above), two types of paths are involved in the claimed invention—convergence paths and a target path for a bore hole. *See* Ex. 1001, 13:15–19. A convergence path—which is used, for example, when “attempting to return to a desired path when drilling has gone off course”—is a possible path from the location of the bottom hole assembly (BHA) to a target path. *Id.* at 2:16–19, 13:16–19.

Regarding the target path, Petitioner contends that “Pirovolou’s ‘predetermined geometric plan of the wellbore’ corresponds to a well plan and would include a target path for a bore hole.” Pet. 29 (citing Ex. 1006 ¶¶ 23–24, 27). As Petitioner notes (*id.* at 25–26), Pirovolou explains that “[t]he target T may be a position on a predetermined geometric plan of the wellbore 2.” Ex. 1006 ¶ 27. Petitioner maps that quoted language to the recited “target path for a bore hole.” Pet. 26. As Petitioner also notes (*id.* at 25), Pirovolou explains that “[t]he target T may be the termination point

of the wellbore 2 or a target between the current position A and the termination point of the wellbore 2.” Ex. 1006 ¶ 27; *see also id.* (“The target T may be the ultimate target . . . and the methods and systems described herein may use intermediate targets . . . to reach the ultimate target T.”). Petitioner asserts that “[t]he ’506 Patent’s description of a ‘target path’ is consistent with how a ‘target’ was understood in the industry at the priority date,” and a person of ordinary skill in the art “would have understood that a target is a location through which a well path must pass.” Pet. 28–29 (citing Ex. 1003 ¶ 106). Dr. Schubert credibly testifies that a person of ordinary skill in the art “would have understood that a well plan includes identified targets and a path to reach them.” Ex. 1003 ¶ 107 (citing, *inter alia*, Ex. 1014, 47<sup>4</sup> (the Landmark User Guide: “A *well plan* consists of a set of targets and instructions for how to hit them.”)); *see also* Ex. 1014, 42 (the Landmark User Guide (cited at Ex. 1003 ¶ 107) identifying phases of well planning including “Pick[ing] drilling targets,” “Group[ing] targets into a well plan,” and then “Balanc[ing] . . . requirements in a recommended well path.”). Thus, in the context of a well plan, references to a “target” are also references to a point on a target path. Although Pirovolou’s Figure 3 does not necessarily depict a complete target path and shows only one target T, we find that Pirovolou nonetheless discloses a target path that passes through one or more targets. *Cf.* Tr. 17:18–22 (Petitioner explaining its contentions during oral argument: “So, the Target T in Pirovolou is along the target path. It doesn’t specifically illustrate a target path, but we see from the

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<sup>4</sup> We, like the parties, for the Landmark User Guide (Ex. 1014), cite to the page numbers of the underlying document rather than the exhibit page numbers.

disclosure . . . that’s discussed on page 18 of the ’022 petition [in IPR2022-00288], where the predetermined plan, the predetermined geometric plan of the wellbore, that corresponds to the target drilling path.”).

Regarding the convergence paths, Petitioner contends that “Pirovolou discloses a plurality of well paths (e.g., paths 28, 30) from the BHA location to a target path.” Pet. 31 (citing Ex. 1003 ¶¶ 100–108, 110 and the arguments made in the context of limitation 1.5); *see also id.* at 25 (“Pirovolou’s method identifies ‘numerous possible trajectories’ . . . . Each wellbore trajectory (path) extends from ‘position A,’ which represents the BHA location, to ‘target T,’ which represents a ‘zone of interest or target.’” (citing Ex. 1006 ¶¶ 27–29, 36, Fig. 1)). Petitioner contends that the two “optional trajectories 28 and 30 extending from position A to target T” shown in Pirovolou’s Figure 3 are examples of convergence paths. *See id.* at 25–26 (quoting Ex. 1006 ¶ 29; citing Ex. 1003 ¶ 103). We agree that Pirovolou’s possible trajectories from position A to target T are convergence paths. Pirovolou, for example, explains that “[o]ften, the drill bit 11 may veer off of a planned drilling trajectory because of the unpredictable nature of the formations being penetrated or the varying forces experienced by the drill bit” and that “the methods and systems described may be applied to predetermined plans, such as to return the drill bit 11 to the predetermined plan.” Ex. 1006 ¶¶ 23–24. Pirovolou describes the possible trajectories as paths to return the well bore (which would have at its end, at position A, the drill bit) to target T, which may be a position on the predetermined well plan. *See id.* ¶ 27.

As mentioned above, the parties agree that an “offset distance” in this limitation means an offset distance of a convergence path relative to the

target path. PO Resp. 12–13; Pet. Reply 2; PO Sur-reply 2. In addition to relying on Pirovolou for the disclosure of the two types of paths, Petitioner contends that Pirovolou teaches a process of determining an optimal convergence path in which a number of parameters are considered. *See, e.g.*, Pet. 31, 34–35, 43–44 (citing, *inter alia*, Ex. 1003 ¶¶ 110, 113, 134; Ex. 1006 ¶¶ 28, 29, 34, 35); *see also, e.g.*, Ex. 1006 ¶ 28 (Pirovolou stating that “the present invention provides a method for correcting the trajectory (or well plan) taking into consideration one or more factors.”).

Petitioner further contends that Budiman describes ways to optimize a well path including optimizing by minimizing the path’s “deviation from geologic targets.” *Id.* at 31 (emphasis omitted) (quoting Ex. 1005, 14:9–11, claims 19 and 20; citing Ex. 1003 ¶ 111). Petitioner asserts that a person of ordinary skill in the art “would have understood that a path’s deviation from a target is the distance by which that path is offset from the target” and maps that to the recited “offset distance for drilling by the BHA each of the convergence paths to the target path.” *See id.* (citing Ex. 1003 ¶ 111). Petitioner contends that, “[f]or Budiman’s algorithm to minimize a path’s deviation from a target, the algorithm would first have to calculate that distance.” *Id.* at 31. Petitioner, relying on the testimony of Dr. Schubert, further contends that:

A POSITA would have understood that there are many ways to calculate a path’s offset distance. EX1003, ¶112. Generally, a well path’s distance from a target would be calculated by measuring the distance from a target to various points along the path. EX1003, ¶112 (discussing EX1014, pp. 205-206 (Turn Point Report and Survey Point Report), 213-214 (Proximity Report)). . . . [A] POSITA would have understood that well paths are often divided into regularly spaced increments or segments for purposes of surveying information about the well

path at each point, including the location of the path. EX1003, ¶112 (discussing EX1014, pp. 206, 213). Similar methods are used to compare the distance between two paths. EX1003, ¶112 (discussing EX1014, p. 213 (Proximity Report)).

*Id.* at 32–33.

Petitioner also asserts that a person of ordinary skill in the art would have had a reason to make the proposed combination of the references’ teachings. *See* Pet. 33–36. Petitioner first contends that a person of ordinary skill in the art “would have been motivated to use the offset-distance measurement from Budiman in the method of Pirovolou because offset distance directly relates to optimizing the well path, for instance by minimizing the overall cost of drilling a well.” *Id.* at 33–34 (citing Ex. 1003 ¶ 113; Ex. 1015 ¶ 39). Petitioner further contends that:

Modifying Pirovolou to additionally utilize an offset-distance variable, as taught by Budiman, to determine the optimal trajectory or path from Pirovolou’s position A to target T would have been the combination of prior art elements (Pirovolou’s selection of an optimal path from Pirovolou’s position A to target T, as shown in Figure 3 of Pirovolou, with Budiman’s calculation of an offset distance) according to known methods (calculating the distance of the well path from geological targets to minimize a well path’s “deviation from geologic targets,” as taught by Budiman) to yield the predictable result of selecting an optimal path that minimizes the path’s deviation from a target, as taught by Budiman. EX1003, ¶113. By the priority date, the industry had already been using various parameters to evaluate the cost of potential well trajectories, and offset distance, as taught by Budiman, is another parameter that a POSITA would have considered in a cost analysis. EX1003, ¶113; EX1015, ¶¶38-39 (discussing optimizing a well path by comparing objective values of each well path and noting that “the longer the path, the higher the cost”).

*Id.* at 34.

According to Petitioner, “Pirovolou already considers a number of variables in its optimization process, and incorporating the additional variable of an offset distance would improve Pirovolou in the same way that the offset distance improves Budiman (by incorporating offset-distance, which impacts cost, into the optimization analysis).” *Id.* at 34–35 (citing Ex. 1003 ¶ 113); *see also id.* at 35 (“Budiman’s disclosure of taking into account the offset distance to minimize the path’s deviation from a target provides a motivation and teaching to a POSITA to factor in a potential path’s offset distance to a target for determining an optimal path.”). Petitioner contends that a person of ordinary skill in the art “would have had a reasonable expectation of success in including this [offset distance] variable in Pirovolou.” *Id.* at 35 (citing Ex. 1003 ¶ 113).

Patent Owner first argues that “*Budiman* does not disclose or render obvious calculating an offset distance of a convergence path (or any path) relative to a target path.” PO Resp. 33 (citing Ex. 2010 ¶ 77); *see also, e.g., id.* at 34 (“[T]hese generic statements in *Budiman* concerning minimizing well path deviation from targets neither disclose nor suggest calculating an offset distance of a convergence path relative to a target path as claimed in the ’506 Patent.”); *id.* at 54–55 (arguing that there is no reason to combine the references’ teachings because Budiman does not disclose calculating an offset distance between the two types of paths). Patent Owner also argues that “*Budiman* at most discloses calculating an offset distance of some sort—but not the specific type claimed.” PO Sur-reply 16. To the extent that Patent Owner argues that Budiman does not teach the entire limitation—and, specifically, a comparison between the two types of paths—this argument is unavailing as it fails to address the challenge as articulated by

Petitioner, which is based on the teachings of the proposed combination of references. *See Bradium Techs. LLC v. Iancu*, 923 F.3d 1032, 1050 (Fed. Cir. 2019) (“A finding of obviousness . . . cannot be overcome ‘by attacking references individually where the rejection is based upon the teachings of a combination of references.’” (quoting *In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986))). Petitioner, in its proposed combination, relies on Pirovolou for a teaching of the two types of paths and contends that Budiman teaches an offset distance variable that would be used in Pirovolou’s selection of an optimal convergence path. *See, e.g.*, Pet. 34 (“Modifying Pirovolou to additionally utilize an offset-distance variable, as taught by Budiman, to determine the optimal trajectory or path from Pirovolou’s position A to target T would have been the combination of prior art elements (Pirovolou’s selection of an optimal path from Pirovolou’s position A to target T, as shown in Figure 3 of Pirovolou, with Budiman’s calculation of an offset distance) according to known methods (calculating the distance of the well path from geological targets to minimize a well path’s ‘deviation from geologic targets,’ as taught by Budiman).”); Pet. Reply 14–15 (Petitioner reiterating its contention that Budiman discloses calculating the distance of deviation but not calculating an offset distance between the two types of paths).

Patent Owner argues that “the Petition has introduced no credible evidence that a [person of ordinary skill in the art] would have understood *Budiman*’s disclosure of minimizing well path deviation from targets as involving calculating an offset distance.” PO Resp. 43. Patent Owner asserts that “Budiman never mentions calculating an offset distance at all.” *Id.* at 33. According to Patent Owner, “*Budiman* describes an approach . . .

in which the calculated paths all intersect with the desired targets,” and that “[o]nly calculating paths that intersect the desired target(s) does not require calculating a path’s deviation from the target(s)—because all of the calculated paths intersect that target.” *See id.* at 35–36 (citing Ex. 2010 ¶¶ 81–82). For the reasons that follow, we find that Petitioner has the better position and that a person of ordinary skill in the art would understand Budiman to teach calculating an offset distance.

Budiman discloses a computerized drill path optimization method utilizing specific mathematical formulae. *See, e.g.*, Ex. 1005, 13:47–14:48. Regarding minimizing deviations from targets, Budiman states:

The optimization problem is posed as one that minimizes the length of the well path. In addition to minimizing length, deviation from geologic targets is also minimized. The optimization criterion, however, is a weighted sum of the two objectives. The multi-criteria optimization problem is simplified by combining the two objectives in a weighted sum.

*Id.* at 14:9–15; *see also id.* at 20:4–10 (dependent claims 19 and 20, with claim 20 reciting that “the objective function [of independent claim 1] is additionally optimized to minimize well path deviation from targets, subject to satisfying constraints on the drilling.”).

Dr. Schubert opines that a person of ordinary skill in the art “would have understood that a path’s deviation from a target is the distance by which that path is offset from the target,” and that, “[f]or Budiman’s algorithm to minimize a path’s deviation from a target, the algorithm would first have to calculate that distance.” Ex. 1003 ¶ 111. Dr. Schubert credibly testifies about the knowledge of the ordinary artisan regarding calculating deviations from targets:

[A person of ordinary skill in the art] would have understood that offset distance [in the challenged patent] refers to a

deviation or distance from a desired location, e.g., how far away a path is from a target. A POSITA would have understood that there are many ways to calculate a path's offset distance. Generally, these calculations would involve calculating the location of the well path at various points and comparing the well path's location to the target's location.

*Id.* ¶ 112; *see also id.* (further explaining how underground locations are calculated). Dr. Schubert, citing the Landmark User Guide, testifies that “[g]enerally, a well path’s distance from a target would be calculated by measuring the distance from a target to various points along the path.” *Id.* (citing Ex. 1014, 205–206, 213–214). The Landmark User Guide describes, *inter alia*, a Proximity report that details the proximity, i.e. distance, between a well plan and an existing well. Ex. 1014, 213–214.

The report includes data on sample points set at regular intervals along the path of the active well plan. *For each sample point, Wellbore Planner computes values* for the closest matching point on the comparison well or comparison well plan.

*Id.* at 214 (emphasis added). This description supports Dr. Schubert’s opinion because that description indicates that persons of ordinary skill in the art would recognize that a distance between a planned well and another item of interest (an existing well, in this description) is a computed, or calculated, value. In light of Budiman’s discussion of calculating an optimized drill path—one that has not yet been drilled—and in light of the knowledge of a person of ordinary skill in the art, we find to be credible Dr. Schubert’s testimony that Budiman discloses calculating a deviation from geologic targets in order to utilize that criterion in its optimization process. Ex. 1003 ¶ 111.

Patent Owner disputes that Budiman discloses calculating a deviation. *See* PO Resp. 34–35. We do not understand Patent Owner, in its opposition,

to argue that a person of ordinary skill in the art, reading Budiman, would be aware of any way to obtain a deviation involving a hypothetical, yet-to-be-drilled path other than by calculating that deviation. Rather, Patent Owner argues that Budiman discloses only calculated paths that would pass through targets, i.e. having zero deviation, and therefore asserts that no calculation of a deviation is performed. *See, e.g., id.* at 35 (“Only calculating paths that intersect the desired target(s) does not require calculating a path’s deviation from the target(s)—because all of the calculated paths intersect that target.” (citing Ex. 2010 ¶ 81)); *see also* Tr. 34:9–19 (“So, our position is that Budiman’s disclosure of minimizing deviation from geologic targets does not involve calculating an offset distance. It simply requires calculating paths that all intersect that target.”). Patent Owner relies on the opinion testimony of Dr. Hilbert.

We find Dr. Hilbert’s testimony to be less credible than Dr. Schubert’s. Dr. Hilbert notes that Budiman has several figures depicting and described as having paths proceeding through targets. Ex. 2010 ¶¶ 83–86. Dr. Hilbert testifies that a person of ordinary skill in the art “would understand that in *Budiman*’s optimization process, the desired target is an input and only paths that intersect the target are calculated.” *Id.* ¶ 82. Thus, Dr. Hilbert opines that a person of ordinary skill in the art would understand Budiman to teach that there never is deviation from targets in Budiman’s process. Dr. Hilbert’s implied opinion that deviation from targets always is a constant with a value of zero is inconsistent with Budiman. Although Budiman does disclose exemplary optimal paths passing through targets (*e.g.*, Ex. 1005, 15:58–60), Budiman also discloses that deviation is a variable to be minimized (while also minimizing path

length). *See id.* at 14:9–14 (“In addition to minimizing length [of the well path], deviation from geologic targets is also minimized.”); *see also* Pet. Reply 17–18 (Petitioner responding that Patent Owner’s “argument that ‘another way of minimizing deviation from a geologic target is by only calculating paths that intersect the target’ lacks merit because [Patent Owner’s] preference for a different modification does not mean it is the only possible modification, or the modification in the Petition.”). In effect, Dr. Hilbert attempts to re-write Budiman’s disclosure of “deviation from geologic targets is also minimized” to “there is no deviation from geologic targets.” *See* Tr. 57:4–15 (Petitioner stating that “Patent Owner is trying to effectively read out the concept of minimizing deviation from Budiman’s disclosure,” and “if you are always going to hit the target, then what’s the point in Budiman of minimizing the deviation from the targets?”). We do not find that Budiman, by disclosing examples where a path passes through a target—i.e., where the deviation to a target has been minimized to zero—negates Budiman’s teaching of the desirability of minimizing deviation or serves as a disclosure that deviation is never calculated.

Patent Owner argues that, “[d]espite the Petition’s conclusory assertion that a [person of ordinary skill in the art] would have understood how to calculate a path’s offset distance, the only evidence in the record describing such an approach is the ’506 Patent itself.” PO Resp. 44 (citing Ex. 2010 ¶ 91). Patent Owner points to a flow chart in the ’506 patent depicting a process for identifying the offset *cost* of a convergence path. *Id.* at 44–46 (citing Ex. 1001, 1:52–54, 8:64–10:49, Fig. 5). The pertinent step is Step 508, which, after dividing the path into segments, is described in the Specification as involving merely “the segment’s distance from the target

path is identified.” *See* Ex. 1001, 9:11–12, Fig. 5. Patent Owner does not direct our attention to any explanation in the Specification of the ’506 patent as to how that distance is calculated or even “identified.” *See* PO Resp. 44–46. The lack of detail in the challenged patent suggests that a person of ordinary skill in the art would have known how to calculate an offset distance. *See Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (“The specification of the [challenged] ’593 patent is entirely silent on how to transmit user locations and maps from a server to a user’s mobile device, suggesting that a person of ordinary skill in the art was more than capable of selecting between the known methods of accomplishing this.”).

Patent Owner attacks Dr. Schubert’s reliance on the Landmark User’s Guide, arguing that “none of the reports in the Landmark User Guide discloses or renders obvious calculating *a convergence path’s* offset distance relative to a target path as part of a process for selecting an optimal convergence path.” PO Resp. 46 (citing Ex. 2010 ¶ 94). However, Dr. Schubert did not opine that the Landmark User Guide teaches the entirety of the limitation, as Patent Owner implies. *See* Ex. 1003 ¶ 112. Rather, as Patent Owner acknowledges, “the Petition and Dr. Schubert rely on the Landmark User Guide as evidence of how location calculations are made and as support for the proposition that well paths are often divided into segments.” PO Resp. 46. We find that the Landmark User Guide supports Dr. Schubert’s opinion and Petitioner’s related arguments. *See, e.g., id.* at 49–50 (Patent Owner noting that the Landmark User Guide discloses that, “[f]or each sample point [along the path of an active well plan], Wellbore

Planner computes values for the closest matching point on the comparison well or comparison well plan.” (quoting Ex. 2014, 214)).

Patent Owner notes Dr. Schubert’s acknowledgement that he is not an expert in optimization algorithms and could not explain how Budiman’s optimization equation or the “objective function” works. *See, e.g., id.* at 35–36 (citing Ex. 2011, 20:22–25, 64:21–65:19), 42; PO Sur-reply 15. We do not view this as undercutting Dr. Schubert’s testimony. Petitioner is not relying on the teaching of a specific optimization algorithm<sup>5</sup> and, regardless as to how the optimization is performed, Dr. Schubert’s testimony on the relevant issue—that Budiman’s optimization process utilizes a calculated deviation value as a consideration—still is credible.

We find that Budiman teaches the use of, as an optimizing parameter, an offset distance from a target, and that the parameter is one that is calculated.

Patent Owner argues that there would have been no reason to combine the teachings of Pirovolou and Budiman. PO Resp. 50–58. Specifically, Patent Owner, relying on the opinion of Dr. Hilbert, asserts (similar to the arguments for Budiman) that Pirovolou discloses only possible trajectories that end at the target, and therefore there is no deviation to minimize. *See id.* at 52–54 (citing Ex. 2010 ¶¶ 102–103; Ex. 1006 ¶ 29, Fig. 3); *id.* at 53–54 (“[A] POSITA would not have been motivated to modify *Pirovolou* to minimize deviation from geologic targets, because *Pirovolou* already

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<sup>5</sup> Patent Owner appears to demand more detail than that required by the claimed subject matter. The challenged claims do not require a specific optimization algorithm. *See, e.g.,* Ex. 1001, 13:23–27 (Claim 1: “selecting one of the convergence paths as an optimal convergence path based on at least one of the [listed factors].”).

minimizes deviation from geologic targets by only calculating paths that intersect with the target.”). Dr. Hilbert notes that Pirovolou’s Figure 3 depicts the two optional trajectories 28 and 30 as intersecting target T, and concludes that there is no deviation to minimize based on the assertion that, in Pirovolou, the paths always intersect target T. Ex. 2010 ¶ 102; Ex. 1029, 105:13–24. On cross-examination, however, Dr. Hilbert conceded that another portion of Pirovolou is “describing that there may be, hypothetically or exemplary, a Trajectory 28 being drilled that fails to strike the Target T.” Ex. 1029, 106:19–25; *but see* PO Sur-reply 17–18 (citing that same testimony—regarding a “hypothetical[] or exemplary” trajectory—and characterizes that as referring to a path that “has already been drilled”). We do not agree with Patent Owner’s implied argument that a person of ordinary skill in the art of drilling would understand Pirovolou to teach that there is no reason to consider a calculated path deviation when determining an optimal path in Pirovolou’s process.

Patent Owner argues that Petitioner’s contention that “offset distance directly relates to optimizing the well path, for instance by minimizing the overall cost of drilling a well” is flawed. PO Resp. 54–55 (quoting Pet. 33–34). According to Patent Owner, Petitioner’s contention is based on reducing cost by minimizing path length and Patent Owner asserts that path length is a separate consideration from minimizing deviation from targets. *See id.* at 55. Petitioner’s proposition that is quoted above and to which Patent Owner refers contains citations to both paragraph 113 of Dr. Schubert’s declaration and to paragraph 39 of Cheng (Exhibit 1015), which is followed by the parenthetical quote: “the longer the path, the higher the cost.” Pet. 33–34; *see also* Pet. Reply 17 (“More deviation at

various points may lead to more cost, analogous to the idea of ‘the longer the path, the higher the cost.’”). Patent Owner argues that Petitioner’s reliance on Cheng is misplaced because “the Petition fails to explain how a motivation to minimize well path length because ‘the longer the path, the higher the cost’ applies to *Budiman*’s alleged offset-distance measurement.” PO Resp. 55 (citing, *inter alia*, Ex. 2010 ¶ 106); *see also id.* at 57 (arguing that Cheng may “suggest[] that a particular measurement—total measured depth of a well trajectory—should be taken into account” but “*Pirovolou*’s method . . . already takes ‘depth’ into account.”).

Even if we were to disregard Cheng and even if Patent Owner is correct that Petitioner’s example of cost being a way that offset distance relates to optimizing is flawed, that does not negate Budiman’s motivating teaching of the desirability of minimizing deviations from targets when optimizing a drill path. *See* Pet. 35 (“Budiman’s disclosure of taking into account the offset distance to minimize the path’s deviation from a target provides a motivation and teaching to a POSITA to factor in a potential path’s offset distance to a target for determining an optimal path.”).

Patent Owner also argues that a person of ordinary skill in the art “would not have had a reasonable expectation of success in making the combination.” PO Resp. 58 (citing Ex. 2010 ¶ 109). Patent Owner asserts, in this regard, that “*Budiman* describes a complex optimization model involving optimizing an objective function” and that a person of ordinary skill in the art “would not have had a reasonable expectation of success of combining *Budiman*’s alleged teachings with *Pirovolou* to arrive at [the offset distance] limitation 1.6.” *Id.* (citing Ex. 1005, code (57) (Abstract), claim 1; Ex. 2011, 20:22–25, 64:21–65:19; Ex. 2010 ¶ 109). This argument

is not persuasive because Petitioner is not proposing to bodily incorporate the entirety of Budiman's optimization model into Pirovolou's system, as Patent Owner implies. *See* Pet. 27–28; *see In re Keller*, 642 F.2d 413, 425 (CCPA 1981) (“The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference[.]”), *quoted with approval in Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016). Rather, Petitioner's proposal is to combine Pirovolou's optimization system, which already considers certain variables, with an offset distance variable as taught by Budiman. *See* Pet. 34. We determine that Petitioner has shown that a person of ordinary skill in the art would have been motivated to include Budiman's optimizing variable in Pirovolou's optimizing process. *See id.* at 33–35; Ex. 1003 ¶ 113. We also find to be credible Dr. Schubert's testimony that “a [person of ordinary skill in the art] would have had a reasonable expectation of success in including [the offset distance] variable in Pirovolou because the variable was already being considered in the similar system of Budiman.” Ex. 1003 ¶ 113.

Based on the arguments and evidence presented by Petitioner, summarized above, and after consideration of Patent Owner's arguments in opposition, we determine that Petitioner has demonstrated that the proposed combination of Pirovolou's process for the selection of an optimal path from multiple possible paths with Budiman's calculated offset distance (deviation from a target) variable teaches or suggests the recited “calculating an offset distance for drilling by the BHA each of the convergence paths to the target path,” where, according to the parties' agreement, “offset distance” means an offset distance of a convergence path relative to the target path. We also

determine that Petitioner has provided adequate reasoning as to why one of ordinary skill in the art would have made the proposed combination and has provided adequate evidence to show that a person of ordinary skill in the art would have had a reasonable expectation of success in doing so.

*e. [1.7] (iii) identifying a drill path curvature of each convergence path;*

Petitioner contends that Pirovolou discloses identifying the dog-leg severity (“DLS”) of a path, and that a dog-leg severity corresponds to the recited “a drill path curvature.” Pet. 36–38. Petitioner, relying, *inter alia*, on the testimony of Dr. Schubert, asserts that “[a] lower DLS indicates a softer curve, while a higher DLS indicates a sharper curve.” *Id.* at 37–38 (citing Ex. 1003 ¶ 119; Ex. 1014, 322)). Dr. Schubert testifies that a person of ordinary skill in the art “would have understood that dog-leg severity (DLS) reflects a path’s curvature.” Ex. 1003 ¶ 119 (citing Ex. 1014 (Landmark User Guide), 151, 322, 388). The cited Landmark User Guide states: “**DLS** (dogleg severity)—*a measure of how curved or twisted the wellbore is between the last turnpoint and this one.*” Ex. 1014, 151 (*italicizing added*). Petitioner contends that Pirovolou’s method of comparing paths uses the dog-leg severity parameter, that dog-leg severity would be determined for each path before performing the comparison, and that Pirovolou discloses or teaches determining the dog-leg severity by a computer program. Pet. 38 (citing Ex. 1003 ¶¶ 120–121; Ex. 1006, code (57) (Abstract), ¶ 22).

Patent Owner reiterates its position that “a drill path curvature” should be construed as limited to the “overall” curvature, and argues that “[t]he ‘dog-leg severity’ described in *Pirovolou* concerns only a given bend in a well path,” and is not the overall curvature of a path. PO Resp. 59. For the

reasons discussed above in the Claim Construction section, we determine that Patent Owner’s proposed construction is incorrect, and conclude that “a drill path curvature” covers any type of curvature and is not limited to the specific “overall” curvature. *See supra* Section II.C.2.

There is no dispute, and we find, that dog-leg severity is a type of curvature. *See, e.g.*, Ex. 1003 ¶ 119 (Dr. Schubert: “dog-leg severity (DLS) reflects a path’s curvature”); Ex. 1029, 64:10 (Dr. Hilbert: “dogleg severity, which is also a curvature”); Ex. 2010 ¶ 60 (Dr. Hilbert referring to “‘a curvature’ of each convergence path (e.g., dog-leg severity)”); PO Sur-reply 18–19 (“*Pirovolou* merely discloses considering individual curvatures of segments of the alleged convergence paths (e.g., the ‘dog-leg-severity (DLS) of the projected trajectory section from A to B’ of proposed trajectories 28 and 30), not the curvature of the convergence path as a whole.”).

We find that Pirovolou teaches or suggests the recited step of “identifying a drill path curvature of each convergence path.”

*f. [1.8] (iv) identifying an amount of time needed to drill each convergence path;*

Petitioner contends that the combination of Pirovolou and Budiman discloses or suggests this limitation. Pet. 38–42. Petitioner asserts that “Budiman includes ‘a drilling influence diagram depicting interactions among drilling variables,’” and that “[o]ne drilling variable identified that impacts cost is ‘Drilling Time,’” which Petitioner maps to the recited “time needed to drill.” *Id.* at 38–39 (citing Ex. 1005, 4:14–15, 4:19–24, Figs. 1A–1B; Ex. 1003 ¶ 124). Petitioner, relying on the testimony of Dr. Schubert, further contends that a person of ordinary skill in the art “would have understood from Budiman that ‘drilling time’ is a variable or parameter to consider when optimizing a well path, e.g., if one desires to

minimize cost,” and that “Budiman expressly discloses that one variable used to optimize a well path is drilling time.” *Id.* at 40–41 (citing Ex. 1003 ¶ 125; Ex. 1005, 6:4–6, 6:63–7:24, Fig. 1B, claims 19, 22). Petitioner contends that drill time would be determined for each path before comparing paths. *Id.* at 41 (citing Ex. 1003 ¶ 125). Petitioner further contends that “the optimization in Budiman is performed using a ‘computer- or software-based method.’” *Id.* (citing Ex. 1003 ¶ 125; Ex. 1005, 3:20–27, 11:3–33). Petitioner asserts that a person of ordinary skill in the art would have had a reason to make the proposed combination because “Pirovolou already considers a number of variables in its optimization process, and incorporating this additional variable (drilling time) would improve Pirovolou in the same way that the drilling time variable improves Budiman.” *Id.* at 42.

Patent Owner agrees that Budiman discloses that drilling time influences cost, but argues that Budiman does not describe comparing paths based on drilling time. PO Resp. 63–64; *see also* Tr. 49:3–4 (“Budiman’s Figure 1B merely indicates that drilling time influences cost.”). Petitioner replies that it relied on the combination of Pirovolou and Budiman for the teaching of overall limitation, not Budiman alone, and specifically asserts that “the Petition relied on Pirovolou’s path comparisons, and merely pointed to Budiman as identifying another well-understood variable (time) a [person of ordinary skill in the art] would have considered when comparing paths.” Pet. Reply 24 (citing Pet. 41 (“A POSITA would have been motivated to use the drilling time parameter from Budiman in the method of Pirovolou. . . .”)). Patent Owner characterizes this as an improper change of theory because the Petition discussed Budiman and also asserted that a

person of ordinary skill would have understood that to compare paths based on drilling time the system would first determine the drilling time. PO Sur-reply 20 (citing Pet. 40–41). We do not regard Petitioner as changing its theory. Although the Petition’s assertion about comparing paths is in a paragraph discussing Budiman, the assertion itself does not state that Budiman discloses comparing paths or cite to Budiman, unlike other propositions in the paragraph. *See* Pet. 40–41. And, the assertion comes after the Petition indicated its reliance on Pirovolou for the disclosure of a plurality of well paths (*id.* at 38) and before articulating its proposed combination as the “use the drilling time parameter from Budiman in the method of Pirovolou,” i.e. a method of comparing the plurality of well paths (*id.* at 41).

To the extent that Patent Owner argues that Budiman fails to teach identifying a drilling time for a path (*see* PO Resp. 65–66), we find Budiman’s disclosure of drilling time as a variable used in optimizing a drill path to at least suggest to a person of ordinary skill in the art that drilling time should be determined. *See, e.g.*, Ex. 1005, 6:4–6 (“The objective score may be cost, probability of success, total time to drill the well, etc.”); *id.* at 20:4–7, 20:14–17 (Budiman’s dependent claims 19 and 22, respectively: “wherein the objective function is additionally optimized to minimize at least one of cost, well path deviation from targets, or *time*” and “wherein the one or more performance metrics include *drilling time*”) (emphasis added)); Ex. 1003 ¶ 125 (Dr. Schubert opining that “Budiman discloses, or at least renders obvious, *identifying an amount of time needed to drill each convergence path.*”). Patent Owner’s argument that Budiman fails to teach the entire limitation is not persuasive. *See, e.g.*, PO Resp. 65 (“The

Petition . . . fails to explain how this disclosure in *Budiman* teaches . . . comparing paths based on drilling time.”); see *Bradium Techs. LLC*, 923 F.3d at 1050 (“A finding of obviousness . . . cannot be overcome ‘by attacking references individually where the rejection is based upon the teachings of a combination of references.’” (quoting *In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986))).

Patent Owner also argues that Petitioner has failed to set forth an adequate reason to make the proposed modification because “[d]rilling time is one of many variables that impact cost,” but “the Petition fails to explain why a [person of ordinary skill in the art] would choose to take drilling time into account over the many other variables that impact cost performance of a drilling operation.” PO Resp. 67–68 (citing Ex. 2010 ¶¶ 123–124; Ex. 1005, Fig. 1B). We do not find this argument persuasive. That there are other obvious combinations does not detract from the obviousness of using the drilling time variable.

Patent Owner asserts that Pirovolou’s method already uses two variables (depth and rate of penetration) that directly influence drilling time, and argues that a person of ordinary skill in the art would not have a reason to further modify Pirovolou to use drilling time. *Id.* at 68–69 (citing Ex. 2010 ¶ 125). Rather than showing a flaw in Petitioner’s case, Patent Owner’s argument that Pirovolou teaches the use of drilling time-related variables supports a conclusion that a person of ordinary skill in the art would find it obvious to use Budiman’s drilling time itself as an optimization variable rather than utilize only variables that merely are related to and influence the drilling time variable. Petitioner argues that “instead of considering multiple factors, a POSITA would consider the

critical overall factor: time.” Pet. Reply 26. We find Petitioner to have the better position.

Based on the arguments and evidence presented by Petitioner, summarized above, and after consideration of Patent Owner’s arguments in opposition, we determine that Petitioner has demonstrated that the proposed combination of Pirovolou’s process for the selection of an optimal path from multiple possible paths with Budiman’s drilling time variable teaches or suggests the recited “identifying an amount of time needed to drill each convergence path.” We also determine that Petitioner has provided adequate reasoning as to why one of ordinary skill in the art would have made the proposed combination and has provided adequate evidence to show that a person of ordinary skill in the art would have had a reasonable expectation of success in doing so.

*g. [1.9] (v) selecting one of the convergence paths as an optimal convergence path based on at least one of the offset distance, the drill path curvature, and the amount of time needed to drill the convergence paths; and*

Petitioner contends that the combination of Pirovolou and Budiman discloses or suggests this limitation. Pet. 43–45. Petitioner asserts that Pirovolou discloses determining an optimal path based on various parameters and that Pirovolou and Budiman collectively disclose or suggest utilizing the recited parameters in the optimizing process. *See id.* Petitioner specifically contends that “Pirovolou discloses determining an optimal path from many possible paths from a BHA to a target path based on various parameters related to each path.” *Id.* at 43–44 (citing Ex. 1006 ¶¶ 28–29, 34–35); Ex. 1003 ¶ 134).

Patent Owner reiterates its arguments that Petitioner has not made an adequate showing regarding the offset distance, drill path curvature, and

drilling time limitations, and argues that “[i]t follows, therefore, that the *Pirovolou-Budiman* combination also fails to disclose or render obvious selecting one of the convergence paths as an optimal convergence path based on at least one of the offset distance, the drill path curvature, and the amount of time needed to drill the convergence paths as recited in limitation 1.9.”

PO Resp. 69–70. For the reasons discussed above, we do not agree with Patent Owner’s underlying arguments regarding the three parameters.

We determine that Petitioner has demonstrated that the proposed combination teaches the “selecting one of the convergence paths as an optimal convergence path” limitation.

*h. [1.10] (vi) controlling the drilling system to drill in accordance with the selected convergence path.*

Petitioner contends that Pirovolou discloses or suggests this limitation. Pet. 45–46. Petitioner asserts that Pirovolou’s controller 19 (also called control system 19) transmits commands to the BHA and directs the BHA and the drilling of wellbore 2 along a selected optimal trajectory, and that a person of ordinary skill in the art would understand that the controller is automatically controlling the drilling. *Id.* (citing, *inter alia*, Ex. 1003 ¶¶ 139–140). Patent Owner does not raise any arguments regarding this limitation of claim 1. We find that, based on the arguments and evidence presented by Petitioner, that Pirovolou discloses or suggests “controlling the drilling system to drill in accordance with the selected convergence path.”

*i. Objective Indicia of Non-Obviousness*

Patent Owner contends that there is evidence of industry praise that constitutes objective indicia of non-obviousness. PO Resp. 71–76 (citing Exs. 2014–2022); PO Sur-reply 22–24. Petitioner argues that there is no nexus between the purported evidence of industry praise and the challenged

claims. Pet. Reply 28–30 (citing, *inter alia*, *Geo. M. Martin Co. v. All. Mach. Sys. Int’l LLC*, 618 F.3d 1294, 1305 (Fed. Cir. 2010) (“Industry praise must also be linked to the patented invention.”). We agree that Patent Owner has not established a nexus to the claimed invention.

“[T]o be accorded substantial weight in the obviousness analysis, the evidence of secondary considerations must have a ‘nexus’ to the claims, i.e., there must be ‘a legally and factually sufficient connection’ between the evidence and the patented invention.” *Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019); *see ClassCo, Inc. v. Apple Inc.*, 838 F.3d 1214, 1220 (Fed. Cir. 2016) (For objective indicia of non-obviousness to be accorded substantial weight, their proponent must establish a nexus between the evidence and the merits of the claimed invention.). “[P]resuming nexus is appropriate when the patentee shows that the asserted objective evidence is tied to a specific product and that product embodies the claimed features, and is coextensive with them.” *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (internal quotations omitted).

Patent Owner asserts that “[Helmerich & Payne, Inc. (‘H&P’)]’s AutoSlide System, which is built over, and relies upon, [Patent Owner] Motive’s (now H&P’s) Bit Guidance System (‘BGS’), practices Claim 1 of the ’506 Patent.” PO Resp. 71–72 (citing Ex. 2003, 3<sup>6</sup>). The cited exhibit

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<sup>6</sup> Patent Owner’s Response actually cites Exhibit 2013 for this proposition. PO Resp. 72. We understand that to be a typographical error. There is no such exhibit in the record, and Patent Owner, in the related *inter partes* review, cited Exhibit 2003 for the same proposition. *See id.* at v (Patent Owner’s exhibit list indicated that the number for Exhibit 2013 is

merely is Patent Owner's contentions, signed by counsel and made in the district court, that BGS and the AutoSlide System are products practicing asserted claims of four patents. Ex. 2003, 1, 3. Thus, Patent Owner here offers a conclusory assertion of nexus that relies on conclusory attorney-argument, rather than evidence. Patent Owner similarly makes the conclusory assertion that "[i]ndustry participants have praised the AutoSlide system, and this evidence is tied to the method for drilling a well using one of a plurality of convergence paths recited in Claim 1." PO Resp. 72 (citing caselaw rather than evidence in the record); *see also, e.g., id.* at 74 (the conclusory assertion that "Motive's directional drilling technology . . . embodies Claim 1 of the '506 Patent"); *id.* at 76 (reiterating the conclusory assertion that "AutoSlide embodies at least Claim 1 of the '506 Patent").

Patent Owner states that "BGS 'analyze[s] millions of potential steering options from sensor data[,] and 'evaluates each path based on drilling time, tortuosity risk and future production potential[.]'" *Id.* at 72 (quoting Ex. 2020, 2) (alterations in original). Patent Owner also states that "AutoSlide, relying on BGS, 'finds optimal parameters in real time to boost rate of penetration and accuracy' and 'standardizes well paths by providing automated slide drilling[.]'" *Id.* (quoting Ex. 2015, 2) (alteration in original). Patent Owner, in its Sur-reply and after Petitioner's argument that Patent Owner had failed to show a nexus, points to these statements and asserts that the "evidence of industry praise is tied to the unique characteristics of the claimed invention and Claim 1 as a whole," and,

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reserved); IPR2022-00288, Paper 18, 73–74 (Patent Owner's Response in the related IPR).

through the use of citations, ambiguously maps those statements to the limitations of independent claim 1. PO Sur-reply 23.

At the hearing, Patent Owner asserted that “[t]he system evaluates each path based on drilling time, tortuosity risk, and future production potential,” and, for the first time, argued that this “corresponds to, for example, the drilling time limitations and the drill path curvature limitation.” Tr. 51:9–12. Similarly, Patent Owner argued that “the BGS system, ‘tells the automation system where, when and how far to slide,’ which corresponds to the limitations regarding outputting the optimal drilling time.” *Id.* at 51:14–16.<sup>7</sup> These attempts to demonstrate a nexus at the hearing, and after the close of all briefing, are untimely. Further, these assertions are mere attorney-argument (including the assertion that “tortuosity risk” and “when . . . to slide” have the same meanings as certain claim terms) that is made without adequate evidentiary support.

Also, at the hearing, when pressed for evidence regarding the comparing of two paths—an aspect that Patent Owner argues distinguishes the claimed invention over the prior art—Patent Owner’s counsel stated that “[w]e do not have anything specific to the offset limitation in terms of description, but the product itself, as I understand it, does involve calculating an offset distance . . . from the convergence path to the target path.” *Id.* at 51:17–52:2; *see, e.g.*, PO Resp. 33 (Patent Owner arguing that “*Budiman*

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<sup>7</sup> Patent Owner has not explained adequately how “outputting the optimal drilling time,” apparently for a single path, corresponds to a claim limitation. The “drilling time” of claim 1 is “identif[ied]” for each of the plurality of possible convergence paths and is an input to the “selecting one of the convergence paths as an optimal convergence path” step. *See* Ex. 1001, 13:21–22, 13:23–27.

does not disclose or render obvious calculating an offset distance of a convergence path (or any path) relative to a target path.”). The understanding of counsel is not evidence from which we can find nexus. Further, it is not clear whether Patent Owner’s evidence is referring to a convergence path to return to the target path (the subject matter of the claims) or merely an optimized target path. Patent Owner also conceded that it has no expert testimony comparing either the BGS system or the AutoSlide system to the claimed invention. Tr. 52:13–16.

Patent Owner argues that it was “recognized as one of the ‘10 Most Promising Energy & Clean Technology Companies Award’ by the ‘Rice Alliance Energy and Clean Technology industry experts’ for their ‘Directional Drilling Bit Guidance System that both reduces drilling costs and improves the overall hydrocarbon production potential of completed wells.[.]’” PO Resp. 73 (citing Ex. 2022, 3). The cited page of the exhibit, which is a LinkedIn article by Patent Owner’s employee (Paper 28, 8), states that Patent Owner’s company was “named one of the Energy and Clean Technology Venture Companies,” and does not say that the award was for the BGS System. *See* Ex. 2022, 3. Rather, with regard to the BGS system, the article states that Patent Owner merely “highlighted” the Directional Drilling Bit Guidance System at the forum. *Id.* Thus, the purported praise from the “industry experts” is for the company, not the claimed invention or even the referenced drilling system. Similarly, Patent Owner argues that “third-party industry surveys conducted by the International Association of Directional Drilling (‘IADD’) demonstrated that the industry recognized H&P / Motive as the leaders in directional drilling.” PO Resp. 74 (citing

Ex. 2021, 17–19). Any purported praise for the companies lacks a nexus to the claimed invention.

Patent Owner cites Exhibit 2017 as praise for “[t]he data-driven software developed by Motive.” *Id.* at 73 (quoting Ex. 2017, 1) (alteration in original). Any praise is for the company and some unspecified technology, and therefore lacks a nexus to the claimed invention or even the BGS or the AutoSlide System.

Even if Patent Owner had provided enough evidence from which we could find a nexus, at least Exhibits 2014, 2017, and 2022 would be entitled to little weight. Patent Owner informs us that “Exhibits 2014 and 2017 . . . originate from Patent Owner (or related entities)” and “Exhibit 2022 is an article published on LinkedIn by Bill Chmela, then-Vice President of Business Development for Patent Owner.” Paper 28, 8, 10. “[S]elf-referential commendation fall[s] well short of demonstrating true industry praise.” *Bayer Healthcare Pharms., Inc. v. Watson Pharms., Inc.*, 713 F.3d 1369, 1377 (Fed. Cir. 2013).

In sum, we have reviewed Patent Owner’s arguments and evidence regarding objective evidence of non-obviousness and, for the reasons outlined above, do not find them persuasive enough to outweigh Petitioner’s evidence that the challenged claim would have been obvious.

*j. Conclusion as to Independent Claim 1*

Having considered the parties’ arguments and evidence, we determine that Petitioner has shown by a preponderance of the evidence that independent claim 1 would have been obvious over Pirovolou and Budiman.

4. *The Alleged Obviousness of Dependent Claims 5 and 9 in View of Pirovolou and Budiman*

Dependent claims 5 and 9 also are challenged under Petitioner's Ground 1. Both of those claims depend directly from independent claim 1.

Claim 5 recites: "The drilling system according to claim 1, wherein the instructions further comprise instructions for eliminating a plurality of actual or potential convergence paths from consideration as an optimal convergence path." Ex. 1001, 13:43–46. Petitioner contends that "Budiman discloses or renders obvious limiting path calculations to include only paths with 'non-negative length of the circular-arc sub-segments' and those that meet a 'restriction on the inclination angles.'" Pet. 46–47 (citing Ex. 1005, 14:35–47). Petitioner reasons that it would have been obvious to use these restrictions in the proposed combination to eliminate, e.g., unrealistic paths. *Id.* (citing Ex. 1003 ¶ 143). Patent Owner does not present separate or additional arguments for claim 5. *See* PO Resp. 70 (Patent Owner relying solely on its arguments regarding the independent claim for all the dependent claims except dependent claim 9).

Dependent claim 9 recites: "The drilling system according to claim 1, wherein the instructions for the step of calculating the offset distance for each of the plurality of convergence paths further comprise instructions for calculating the offset distance for a plurality of segments making up a convergence path of the plurality of convergence paths." Ex. 1001, 13:62–67.

Petitioner contends that Budiman teaches and that it was known in the art that paths are composed of segments and that well path parameters are provided for each segment. Pet. 49–52 (citing, *inter alia*, Ex. 1005, 2:40–43, 5:59–66; Ex. 1003 ¶¶ 149–153). Petitioner further contends that a person of

ordinary skill in the art would have been motivated to calculate the offset distance for each segment of a path. *Id.* at 52–55 (citing, *inter alia*, Ex. 1003 ¶¶ 154–156; Ex. 1014, 205 (Landmark User Guide)).

Patent Owner argues that Petitioner’s contentions for dependent claim 9 do not cure the underlying deficiencies in Petitioner’s case for the offset distance limitation of the independent claim. PO Resp. 70–71. For the reasons discussed above, we do not find Petitioner’s case for the offset distance limitation to be deficient as argued by Patent Owner. *See supra* Section II.D.3.d.

We have considered the evidence and arguments of record and determine that Petitioner has demonstrated by a preponderance of the evidence that dependent claims 5 and 9 would have been obvious based on Pirovolou and Budiman for the reasons discussed in the Petition.

*E. The Alleged Obviousness of Claims 2, 5, and 6 in View of Pirovolou, Budiman, and Schottle (Ground 2)*

*The Alleged Obviousness of Claim 10 in View of Pirovolou, Budiman, and Alft (Ground 3)*

*The Alleged Obviousness of Claim 4 in View of Pirovolou, Budiman, Schottle, and Johnston (Ground 4)*

*The Alleged Obviousness of Claim 3 in View of Pirovolou, Budiman, Schottle, Johnston, Boone, and Downton (Ground 5)*

The remaining challenged claims are dependent claims. Petitioner identifies teachings in the prior art references that teach or suggest the limitations of each of these dependent claims, and provides persuasive reasoning as to why the claimed subject matter would have been obvious to one of ordinary skill in the art. Pet. 56–85. Patent Owner does not present separate or additional arguments for these grounds. *See* PO Resp. 70 (“Grounds 2–5 rely solely on the analysis of *Pirovolou* and *Budiman* set

forth in Ground 1 for the above-identified limitations, and therefore fail for the same reasons.”); PO Sur-reply 22–23.

We have considered the evidence and arguments of record and determine that Petitioner has demonstrated by a preponderance of the evidence that claims 2–6, and 10 would have been obvious based on the relied-on prior art for the reasons discussed in the Petition for Grounds 2–5.

### III. PETITIONER’S MOTION TO EXCLUDE EVIDENCE

Petitioner moves to exclude Patent Owner’s Exhibits 2014–2018 and 2020–2022. Paper 27, 1. Petitioner argues that “Exhibits 2014–2018 and 2020–2022 contain inadmissible hearsay,” that “Exhibit 2021 contains prejudicial information that substantially outweighs any probative value of that information,” and that “Exhibit 2022 is not the original writing containing the information that Patent Owner relies upon and therefore is inadmissible because it is not the best evidence.” *Id.* at 1–2. These exhibits pertain to Patent Owner’s assertions of industry praise as objective indicia of non-obviousness. *See id.* at 2; *see also, e.g.*, Paper 28, 1 (Patent Owner’s opposition to the motion, arguing that “the Challenged Exhibits are not offered solely for the truth of the matter, but also as evidence that statements praising Motive’s Autoslide/BGS system were made.”).

For the reasons discussed above, we determine that Patent Owner has not established any nexus between the claimed inventions and the purported evidence of industry praise. We also determine that Petitioner has shown that the challenged claims are unpatentable even taking these exhibits into consideration. As such, resolution of Petitioner’s motion to exclude with respect to these exhibits would have no effect on our decision making and is therefore moot. Accordingly, we *dismiss* Petitioner’s Motion to Exclude.

#### IV. CONCLUSION<sup>8</sup>

Petitioner has shown by a preponderance of the evidence that claims 1–6, 9, and 10 of the '506 patent are unpatentable over the relied-on prior art.

In summary:

| <b>Claims</b>              | <b>35<br/>U.S.C. §</b> | <b>Reference(s)/Basis</b>                                       | <b>Claims<br/>Shown<br/>Unpatentable</b> | <b>Claims<br/>Not Shown<br/>Unpatentable</b> |
|----------------------------|------------------------|-----------------------------------------------------------------|------------------------------------------|----------------------------------------------|
| 1, 5, 9                    | 103                    | Pirovolou,<br>Budiman                                           | 1, 5, 9                                  |                                              |
| 2, 5, 6                    | 103                    | Pirovolou,<br>Budiman, Schottle                                 | 2, 5, 6                                  |                                              |
| 10                         | 103                    | Pirovolou,<br>Budiman, Alft                                     | 10                                       |                                              |
| 4                          | 103                    | Pirovolou,<br>Budiman, Johnston                                 | 4                                        |                                              |
| 3                          | 103                    | Pirovolou,<br>Budiman, Schottle,<br>Johnston, Boone,<br>Downton | 3                                        |                                              |
| <b>Overall<br/>Outcome</b> |                        |                                                                 | 1–6, 9, 10                               |                                              |

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<sup>8</sup> Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

V. ORDER

For the foregoing reasons, it is

ORDERED that claims 1–6, 9, and 10 of the '506 patent have been proven to be unpatentable;

FURTHER ORDERED that Petitioner's Motion to Exclude (Paper 27) is *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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