

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DJI EUROPE B.V.,
Petitioner,

v.

DAEDALUS BLUE LLC,
Patent Owner.

IPR2020-01474
Patent 7,228,232 B2

Before BARRY L. GROSSMAN, ERIC C. JESCHKE, and
ARTHUR M. PESLAK, *Administrative Patent Judges*.

PESLAK, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Petitioner, DJI Europe B.V., filed a Petition (Paper 2, “Pet.”) requesting an *inter partes* review of claims 1–6 and 13–18 (the “challenged claims”) of U.S. Patent No. 7,228,232 B2 (Ex. 1001, “the ’232 patent”). Petitioner filed a Declaration of Dr. R. John Hansman, Jr. in support of the Petition. Ex. 1003. Patent Owner, Daedalus Blue LLC, timely filed a Preliminary Response (Paper 7). Taking into account the arguments presented in Patent Owner’s Preliminary Response, we determined there was a reasonable likelihood Petitioner would prevail in its contention that at least one of the challenged claims of the ’232 patent is unpatentable under 35 U.S.C. § 103(a). On February 12, 2021, we instituted this *inter partes* review as to the challenged claims and all grounds presented in the Petition. Paper 15 (“Dec.”).

During the course of trial, Patent Owner filed a response to the Petition. Paper 22 (“PO Resp.”). In support of the Patent Owner Response, Patent Owner filed a Declaration of Dr. Daniel S. Kaputa. Ex. 2011. Petitioner filed a Reply to the Patent Owner Response. Paper 24 (“Pet. Reply”). Patent Owner then filed a Sur-reply. Paper 25 (“Sur-reply”). An oral hearing was held on November 16, 2021, and a transcript of the hearing is entered into the record. Paper 31 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of the challenged claims of the ’232 patent. For the reasons discussed below, we determine Petitioner does not establish by a preponderance of the evidence that any challenged claim of the ’232 patent is unpatentable.

A. Related Matters

The parties state that the '232 patent is asserted in *Daedalus Blue LLC v. SZ DJI Technology Co., Ltd., & DJI Europe B.V.*, Case No. 6:20-cv-0073 (W.D. Tex.). Pet. 91; Paper 5, 2. The '232 patent is also the subject of IPR2020-01475, filed by Petitioner concurrently with this proceeding. Pet. 91.

B. Real Parties-in-Interest

Petitioner identifies itself and DJI Technology Inc., SZ DJI Technology Co., Ltd., iFlight Technology Company Limited, DJI Japan K.K., and DJI Research LLC as real parties-in-interest. Pet. 91. Patent Owner identifies itself as the only real party in interest. Paper 5, 2.

C. The '232 Patent (Ex. 1001)

The '232 patent is titled Navigating a UAV¹ with Obstacle Avoidance Algorithms. Ex. 1001, code (54). The '232 patent issued on June 5, 2007 from an application filed on January 24, 2005. *Id.* at codes (45), (22).

The '232 patent is directed to “[m]ethods, systems, and computer program products . . . for navigating a UAV that include piloting the UAV, under control of a navigation computer, in accordance with a navigation algorithm.” Ex. 1001, 1:34–37. Embodiments of the '232 patent “include reading from the GPS receiver a sequence of GPS data, anticipating a future position of the UAV, identifying an obstacle in dependence upon the future position, selecting an obstacle avoidance algorithm, and piloting the UAV in accordance with an obstacle avoidance algorithm.” *Id.* at 1:37–42.

Figure 1 of the '232 patent, reproduced below, illustrates various components of a system for navigating an UAV. Ex. 1001, 4:48–50.

¹ “UAV” is short hand for an “unmanned aerial vehicle.” Pet. 1.

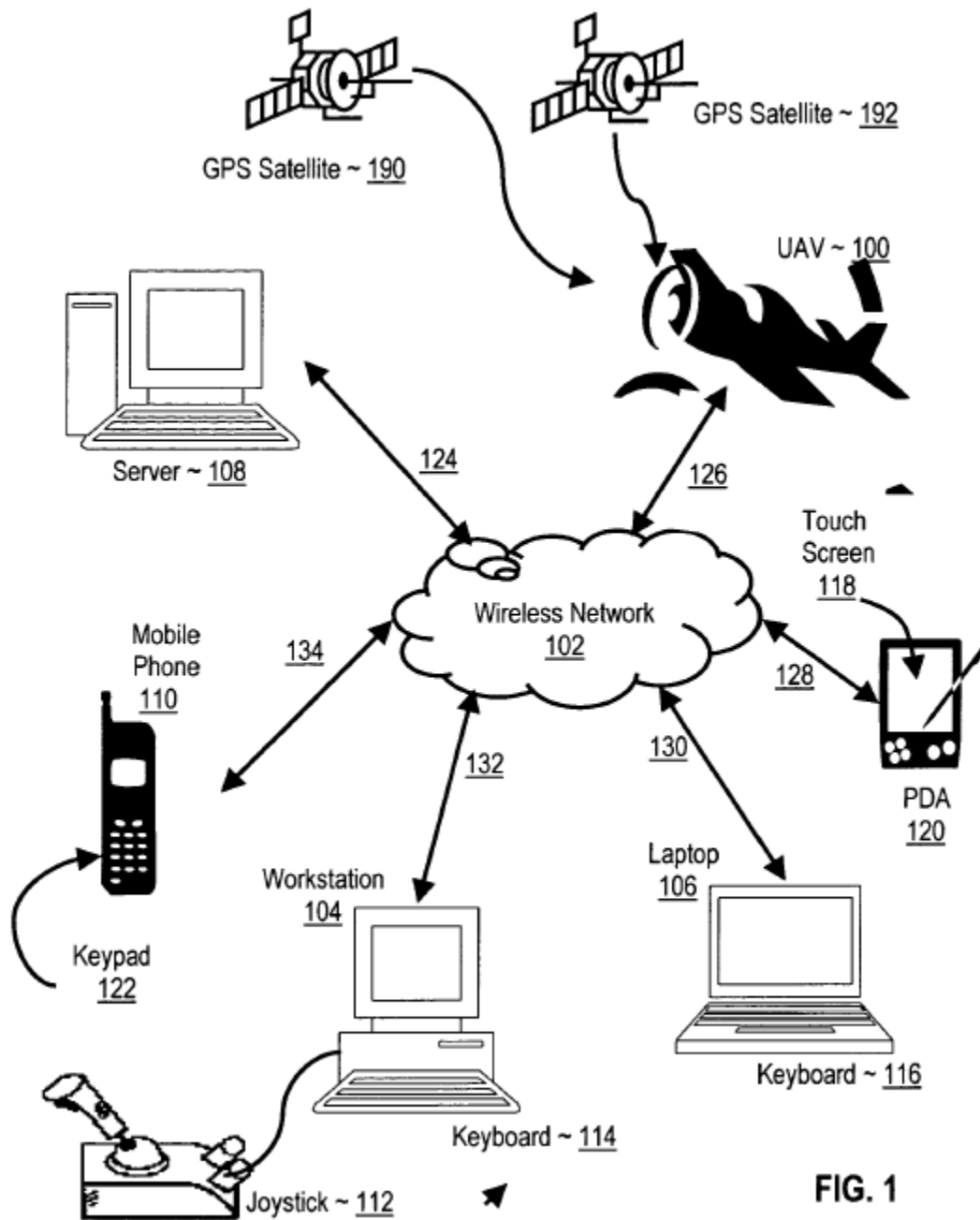


Figure 1 of the '232 patent “illustrat[es] relations among components of an exemplary system for navigating a UAV.” *Id.* at 2:10–12.

In the system shown in Figure 1, UAV 100 “includes a GPS (Global Positioning System) receiver (not shown) that receives a stream of GPS data from satellites (190, 192).” Ex. 1001, 4:50–53. UAV 100 is navigated “by

receiving in a remote control device a user's selection of a GUI [graphical user interface] map pixel that represents a waypoint for UAV navigation.” *Id.* at 4:57–60. Exemplary remote control devices include mobile telephone 110, laptop computer 106, and personal digital assistant 120. *Id.* at 4:61–64. The remote control devices “map the pixel[] location on the GUI to Earth coordinates of a waypoint and . . . transmit the coordinates of the waypoint to the UAV (100)” through wireless network 102. *Id.* at 5:8–13. The system shown in Figure 1 “is capable of operating a UAV to read a starting position from a GPS receiver . . . on the UAV and pilot the UAV, under control of a navigation computer on the UAV, from a starting position to a waypoint in accordance with a navigation algorithm.” *Id.* at 5:30–35. The system also reads “a sequence of GPS data, anticipat[es] a future position of the UAV, identif[ies] an obstacle in dependence upon the future position, select[s] an obstacle avoidance algorithm, and pilot[s] the UAV in accordance with an obstacle avoidance algorithm.” *Id.* at 6:43–49.

D. *Challenged Claims*

Claims 1 and 13 are independent. Claim 1 is reproduced below:

A method for navigating a UAV, the method comprising:
 piloting the UAV, under control of a navigation computer in accordance with a navigation algorithm;
 while piloting the UAV:
 reading from a GPS receiver a sequence of GPS data;
 anticipating a future position of the UAV in dependence upon the sequence of GPS data;
 identifying an obstacle in dependence upon the future position;
 selecting an obstacle avoidance algorithm; and
 piloting the UAV in accordance with the selected obstacle avoidance algorithm.

Ex. 1001, 21:7–19.

E. Prior Art and Asserted Grounds

Petitioner asserts that claims 1–6 and 13–18 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 6, 13, 18	103(a) ²	Sanders ³
2, 14	103(a)	Sanders, Pilley ⁴
3, 15	103(a)	Sanders, Suiter ⁵
4, 5, 16, 17	103(a)	Sanders, Pappas ⁶
1–3, 6, 13–15, 18	103(a)	Duggan ⁷ , Pilley
4, 5, 16, 17	103(a)	Duggan, Pilley, Sainthuile ⁸

II. ANALYSIS

A. Overview

Petitioner bears the burden of establishing the unpatentability of the challenged claims by a preponderance of the evidence. 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2020). This burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

² The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 102. Because the ’904 patent was filed before the effective date of the relevant amendment, the pre-AIA version of § 103 applies.

³ Christopher P. Sanders, *Real-time Collision Avoidance for Autonomous Air Vehicles*, (M.I.T. 1998) (Ex. 1005) (“Sanders”).

⁴ U.S. Patent No. 5,867,804 issued Feb. 2, 1999 (Ex. 1010) (“Pilley”).

⁵ U.S. Patent No. 6,690,299 B1 issued Feb. 10, 2004 (Ex. 1011) (“Suiter”).

⁶ George J. Pappas, *Conflict Resolution for Multi-Agent Hybrid Systems*, (1996) (Ex. 1015) (“Pappas”).

⁷ U.S. Patent No. 7,343,232 B2 issued Mar. 11, 2008 (Ex. 1012) (“Duggan”).

⁸ U.S. Patent No. 6,546,338 B2 issued April 8, 2003 (Ex. 1013) (“Sainthuile”).

A claim is unpatentable under § 103(a) 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) when in evidence, objective indicia of non-obviousness (i.e., secondary considerations).⁹ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

Petitioner contends that a skilled artisan “would have had a bachelor’s degree in aeronautical engineering, electrical engineering, computer science or equivalent training and experience, and at least two years of experience in the field of unmanned vehicles.” Pet. 7–8 (citing Ex. 1003 ¶ 20). Petitioner further contends that “[a]dditional work or research experience can substitute for less or different education, and vice-versa.” *Id.* at 8. Patent Owner appears to apply Petitioner’s level of ordinary skill in the art. *See* PO Resp. 18.

Based on the complete record, we adopt Petitioner’s proposed level of ordinary skill in the art because it comports with the level of skill reflected in the ’232 patent and the prior art of record.

⁹ Neither party has submitted evidence concerning secondary considerations.

C. Claim Construction

We apply the same claim construction standard used by Article III federal courts and the International Trade Commission, both of which follow *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. 37 C.F.R. § 42.100(b). Accordingly, we construe each challenged claim of the '232 patent to generally be “the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” *Id.*

Petitioner contends that no claim terms require express construction. Pet. 8. Petitioner submits a chart detailing disclosure in the '232 patent of the corresponding function and structure for the means plus function claim elements recited in claims 13–18. *Id.* at 8–10.

Claim 1 recites “selecting an obstacle avoidance algorithm” and claim 13 recites “means . . . for selecting an obstacle avoidance algorithm.” Ex. 1001, 21:17, 22:57–58. In our Decision on Institution, we explained “Patent Owner’s contentions are implicitly based on a construction of the phrase in claim 1 ‘selecting an obstacle avoidance algorithm’ as ‘selecting an obstacle avoidance algorithm *from a plurality of collision avoidance algorithms.*”” Dec. 24. We explained that Petitioner “appears to implicitly rely on a construction of claim 1 similar to that proposed by Patent Owner.” *Id.* at 25. Notwithstanding this, we explained the language of claim 1 does not appear to require selecting or choosing from more than one collision avoidance algorithms but, the sequence of steps suggests merely “choosing an obstacle avoidance algorithm in place of the recited navigation algorithm after an obstacle is detected.” *Id.* Further, we invited the parties to brief the proper construction of “selecting.” *Id.* at 26.

Patent Owner now explicitly advocates for this construction. PO Resp. 18. In particular, Patent Owner contends this term requires “a selection from multiple possible collision avoidance algorithms made in the context of the obstacle.” *Id.* at 21. In support of this construction, Patent Owner cites to various portions of the Specification. *See id.* at 18–21 (citing Ex. 1001, 19:27–34, 20:13–14, 20:16–49, 20:52–65, Figs. 16–20). For example, Patent Owner directs us to “[t]he method shown and described in Figures 17 and 18 results in a flight path that returns the UAV to its originally anticipated course.” *Id.* at 19 (citing Ex. 1001, 20:13–14, Figs. 17, 18). Patent Owner also directs us to “another obstacle avoidance algorithm taught by the ’232 patent and that can be selected from . . . a flight path that does not return the UAV to its originally anticipated course.” *Id.* (citing Ex. 1001, Fig. 19, 20). Patent Owner also provides testimony from Dr. Kaputa in support of this construction. Ex. 2011 ¶¶ 39–42.

Petitioner takes no position on the construction of “selecting.” Pet. Reply 3. Rather, Petitioner contends “[r]esolution of the construction of ‘selecting’ is not necessary to resolve the dispute because . . . Sanders teaches ‘selecting’ under either construction.” *Id.*

Although Petitioner provides no explicit claim construction analysis in either the Petition or the Reply, in analyzing the challenge based on Sanders, the Petition states “Sanders implemented DSAAV¹⁰ system includes two collision avoidance algorithms: the bang-bang maneuver and the continuous maneuver.”¹¹ Pet. 21. Petitioner then contends “Sanders’ algorithm selects

¹⁰ “DSAAV” refers to the Draper Small Autonomous Air Vehicle. Ex. 1005, 21.

¹¹ Sanders describes the bang-bang maneuver and the continuous maneuver. *See* Ex. 1005, 68 *et. seq.*

a maneuver (bang-bang or continuous).” *Id.* at 23. Dr. Hansman likewise testifies “Sanders’ implemented DSAAV system includes two types of collision avoidance algorithms: bang-bang and continuous maneuvers” and “[t]he CAS selects one of these algorithms when an obstacle is detected.” Ex. 1003 ¶ 101. Similarly, Petitioner applies Patent Owner’s construction of selecting in analyzing Ground 5. Pet. 70–71. Thus, both Dr. Hansman and Petitioner analyze the claims using Patent Owner’s construction that both “selecting an obstacle avoidance algorithm” in claim 1 and “means for . . . selecting an obstacle avoidance algorithm” in claim 13 require selection from one or more collision avoidance algorithms.

Because the Petition implicitly applies the same construction proposed by Patent Owner in both of grounds 1 and 2, there is no dispute between the parties. Consequently, we evaluate the Petition using Patent Owner’s construction of “selecting.” 37 C.F.R. § 42.104 (b)(3) (the Petition must contain a statement “[h]ow the challenged claim is to be construed”); *see also Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (noting that “we need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy’”) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Patent Owner also provides a table of District Court constructions of certain means plus function claim limitations recited in claims 13–16. PO Resp. 22–26. Patent Owner contends we should apply these constructions if necessary. *Id.* at 26. Petitioner does not dispute Patent Owner’s contention that we should apply the District Court constructions. Pet. Reply 3.

Patent Owner also provides a proposed construction of two means plus function claim limitations recited in claim 15. PO Resp. 27–30.

Petitioner contends Patent Owner’s proposed construction of these terms is inconsistent with the District Court construction. Pet. Reply 4.

We need not address the construction of any of the means plus function claim terms because it is not necessary to our Decision. *See Nidec Motor Corp.* 868 F.3d at 1017.

D. Ground 1: Alleged Obviousness over Sanders

Petitioner contends that claims 1, 6, 13, and 18 are unpatentable over Sanders. Pet. 12–34. In support thereof, Petitioner identifies the disclosures in Sanders alleged to describe the subject matter in the challenged claims. *Id.* Additionally, Petitioner offers declaration testimony from Dr. Hansman in support of the Petition. Ex. 1003 ¶¶ 68–167.

Patent Owner contends Sanders does not teach or suggest selecting an obstacle avoidance algorithm. PO Resp. 34. Additionally, Patent Owner offers declaration testimony from Dr. Kaputa. Ex. 2011 ¶¶ 46–62.

We begin our analysis with a brief overview of Sanders. We then address the parties’ respective contentions with respect to the challenged claims.

Sanders – Ex. 1005

Sanders is titled “Real-time Collision Avoidance for Autonomous Air Vehicles” and bears a copyright date of 1998. Ex. 1005. Sanders is a master’s degree thesis describing “the design and analysis of a collision avoidance system (CAS) for autonomous air vehicles.” *Id.* at Abstract. The document focuses on “algorithm design, multi-AAV simulation, closed-loop analysis, and actual vehicle flight tests.” *Id.* Sanders discloses a “guidance, navigation, and control (GNC) system” for autonomous air vehicles (“AAV’s”). *Id.* at 22–23. The CAS engages in conflict detection and resolution. *Id.* at 55.

Sanders describes two collision avoidance maneuvers. Ex. 1005, 68. The first is referred to as bang-bang maneuvers and the second is referred to as continuous maneuvers. *Id.*

Bang-bang maneuvers “generally consist of a one-time avoid command and a one-time return command.” Ex. 1005, 68. “The return command brings the AAV back to its original trajectory after the conflict has been eliminated.” *Id.* Sanders describes the bang-bang maneuver as “open-loop” meaning “once it begins, it does not recalculate or readjust unless a new potential conflict has been created.” *Id.* Sanders discloses that the timing of the avoid command is especially important because if started “too near the time of the conflict, it may prove too late.” *Id.* at 69.

Continuous maneuvers are closed loop, meaning that they “reevaluat[e] the avoidance command at each step.” Ex. 1005, 71. Sanders discloses “[t]here are endless possibilities for continuous conflict resolution maneuvers but most seem to have one thing in common: generating optimized trajectories.” *Id.* Sanders describes the design of a bang-bang algorithm. Ex. 1005, 73–78.

Sanders also describes a number of limitations with the bang-bang algorithm, which “sparked the design for the continuous DSAAV collision avoidance controller.” *Id.* at 78. Sanders describes a “[c]ontinuous [a]lgorithm” that “was designed to be an improvement over the bang-bang collision avoidance system.” Ex. 1005, 78. Sanders further describes “want[ing] to eliminate the shortcomings of the open-loop controller, especially the all-or-nothing behavior which gets it into trouble sometimes.” *Id.* Unlike the bang-bang algorithm, Sanders’ continuous controller “strives to send the vehicles on smooth, gradual trajectories” and “[a]ny disturbances

should generally have time to correct themselves before a conflict occurs.”
Id. at 79.

Claim 1

Petitioner cites to various disclosures in Sanders alleged to disclose each limitation of claim 1 and also provides supporting testimony from Dr. Hansman. Pet. 12–25. Patent Owner only disputes Petitioner’s contentions with respect to the limitation “selecting an obstacle avoidance algorithm.” PO Resp. 34–42. We focus our analysis on this limitation.

Selecting an Obstacle Avoidance Algorithm

As discussed above in our claim construction analysis, this limitation requires “a selection from multiple possible collision avoidance algorithms made in the context of the obstacle.”

Petitioner contends Sanders’ “system includes two collision avoidance algorithms: the bang-bang maneuver and the continuous maneuver.” Pet. 21 (citing Ex. 1005, 68). Petitioner contends the bang-bang maneuver consists of a one-time avoid command and a one-time return command and “the CAS software determines whether to maneuver up or down.” *Id.* (citing Ex. 1005, 68, 74, 76). Petitioner further contends that the “continuous maneuver ‘strives to send the vehicles on smooth, gradual trajectories’” but like the bang-bang maneuvers “determines whether to maneuver up or down to ‘minimize[] the AAV’s deviations from their current trajectories.” *Id.* at 22 (citing Ex. 1005, 79, 83) (alteration in original). Based on the foregoing, Petitioner contends “Sanders’ algorithm selects a maneuver (bang-bang or continuous), parameters, and direction (e.g., up or down)” and “therefore teaches ‘*selecting an obstacle avoidance algorithm.*” *Id.* at 23 (citing Ex. 1003 ¶¶ 101–107). Petitioner further contends that because the collision avoidance system operates in real-time while an AAV is flying a mission,

“Sanders’ system performs the ‘*selecting*’ function ‘*while piloting the UAV.*’” *Id.* at 20–21 (citing Ex. 1003 ¶ 107).

Patent Owner contends “Petitioner mischaracterizes Sanders by arguing that it teaches *selection* of a UAV algorithm while piloting the UAV.” PO Resp. 37 (citing Pet. 21). According to Patent Owner, “no such selection (choice) was ever taught or suggested, because Sanders never intended that both the bang-bang algorithm and the continuous algorithm would ever be made available (e.g., for selection) concurrently on a UAV.” *Id.* Patent Owner concedes that Sanders describes both a bang-bang algorithm and a continuous algorithm. *Id.* In support of its contention that Sanders never intended for both to be available for selection, Patent Owner points to the disclosure in Sanders that “[t]he continuous controller was designed to be an improvement over the bang-bang collision avoidance system.” *Id.* at 34 (citing Ex. 1005, 78). Patent Owner further contends “the bang-bang algorithm was deemed unsuitable . . . and Sanders identified only the continuous algorithm as the one ‘which will probably be used in the flight tests.’” *Id.* (citing Ex. 1005, 72, 73, 78, 79); *see also id.* at 36–37 (arguing the same (citing Ex. 1005, 74–78, Figs. 4.6, 4.10; Ex. 2011 ¶¶ 51–62)). Patent Owner further contends because “Sanders intended only the continuous algorithm to ever be flown, there would never be any ‘selection’ among collision avoidance algorithms at all” as required by claim 1. *Id.* at 38.

Patent Owner next disputes Petitioner’s contention that “the selection of a single maneuver within an obstacle avoidance algorithm meet[s] the requirements of the claims.” PO Resp. 39 (citing Pet. 21–23). Patent Owner contends that “[m]aneuvers, for example as in the case of Sander’s bang-bang algorithm, generally consist of individual one-time commands, e.g., to

go up or down.” *Id.* (citing Ex. 1005, 68). Patent Owner further contends “algorithms are not one time commands” but rather “a sequence of steps for solving a logical or mathematical problem or performing a task.” *Id.* (citing Ex. 2005). Patent Owner contends Sanders discloses “[s]ince the [UAVs] always have two possible maneuver directions, up and down, [a] collision avoidance algorithm must set some criterion to choose between the two.” *Id.* at 40 (citing Ex. 1005, 76). Patent Owner further contends “more than just a maneuver, a collision avoidance algorithm requires ‘some criterion to choose’ between maneuvers and so selection of different maneuvers within a single collision avoidance algorithm cannot itself be selection from among different algorithms.” *Id.* (citing Ex. 2011 ¶¶ 57–60).

Petitioner, in turn, contends “Sanders discloses ‘selecting’ . . . because the AAV . . . must choose between an ‘up’ and a ‘down’ algorithm when running the ‘continuous’ obstacle avoidance algorithm.” Pet. Reply 7 (citing Ex. 1005, 83, Fig. 4.13). In connection with Sanders’ Fig. 4.13, Petitioner contends “[t]he continuous algorithm determines whether to maneuver up . . . or down . . . to ‘minimize[] the AAV’s deviations from their current trajectories.’” *Id.* (citing Ex. 1005, 83, Fig. 4.13). Based on Dr. Hansman’s deposition testimony, Petitioner contends “that ‘the algorithm which guides the up maneuver would or could be different from the algorithm that provides the [down] route.’” *Id.* (citing Ex. 2010, 43:1–13). Petitioner further contends “the ‘up’ and ‘down’ algorithms are not simply ‘one time commands.’” *Id.* at 8. Petitioner again points to Dr. Hansman’s deposition testimony that “the overall structure includes the – the logic for selecting the direction, and then there’s the sub-algorithm that then determine the trajectory – you know, how fast to pull up, how long to go, et cetera.” *Id.* (citing Ex. 2010, 43:21–44:9). Petitioner points to the obstacle avoidance

algorithms in the '232 patent cited by Patent Owner (PO Resp. 18–21) and contends Patent Owner “fails to explain, however, the distinction between what is disclosed in the '232 patent and what is disclosed by Sanders.” Pet. Reply 8–9.

Patent Owner replies that choosing between an up and down algorithm when running Sanders’ continuous algorithm does not meet the requirements of claim 1 because claim 1 requires selecting the collision avoidance algorithm while piloting the UAV “in accordance with a navigation algorithm.” Sur-reply 5; *see also id.* at 6 (“[A]ccording to claim 1 the selection of the collision avoidance algorithm occurs *while piloting the UAV in accordance with a navigation algorithm.*” (citing Ex. 2010, 94:8–22)). According to Patent Owner, “[t]he navigation algorithm is distinct from a selected collision avoidance algorithm.” *Id.* at 6 (citing Ex. 1001, 18:7–22, 19:23–27, Fig. 16; Ex. 2010, 91:11–22, 94:8–22; Ex. 2011 ¶¶ 43–44). Patent Owner contends that even if Petitioner is correct that choosing between Sanders’ up and down maneuvers constitutes selecting an obstacle avoidance algorithm, “such choosing *when running* an obstacle avoidance algorithm is still **not** selection ‘in accordance with a navigation algorithm,’ as required by claim 1.” *Id.* at 7. Patent Owner further contends the selection between the up and down algorithms “would be, if anything, a selection made according to the then-running obstacle avoidance algorithm.” *Id.* (citing Ex. 2010, 42:11–44:14).

For the following reasons, we find Petitioner has not established that Sanders discloses “selecting an obstacle avoidance algorithm” as required by claim 1.

The Petition specifically states that Sanders system includes “two collision avoidance algorithms: the bang-bang maneuver and the continuous

maneuver” and “selects a maneuver (bang-bang or continuous).” Pet. 21, 23. Dr. Hansman, likewise, testifies Sanders “selects one of these algorithms when an obstacle is identified.” Ex. 1003 ¶ 101. Petitioner, however, does not dispute Patent Owner’s contention that Sanders only intended the continuous algorithm to be flown. *See generally* Pet. Reply. We now turn to the disclosure in Sanders concerning whether Sanders at least suggests that both collision avoidance algorithms would be available for selection during flight.

Sanders discloses it anticipated running actual flight tests on vehicles with its CAS “in the coming year.” Ex. 1005, 136. The fact that Sanders had not yet engaged in any actual flight testing is not dispositive of whether Sanders teaches or suggests that both the bang-bang algorithm and the continuous algorithm would be available for selection during flight. After discussing the bang-bang algorithm, Sanders states that limitations of the bang-bang maneuver “sparked the design for the continuous DSAAV collision avoidance controller, described next.” *Id.* at 78. Sanders begins the description of the continuous controller by stating that “we wanted to eliminate the shortcomings of the open-loop controller, especially the all-or-nothing behavior which gets it into trouble.” *Id.* Sanders also states “the continuous controller . . . will probably be used in the flight tests.” *Id.* at 73. Petitioner does not point to any disclosure in Sanders that it contemplated using both algorithms in upcoming flight tests nor has our independent review resulted in any disclosure from which it could be inferred that Sanders intended to include both algorithms during flight tests.

In light of the foregoing, we find Petitioner has not shown that Sanders teaches or suggests that two collision avoidance algorithms would be available for selection during flight. In the absence of such a teaching or

suggestion, to the extent Petitioner contends Sanders teaches a selection between the bang-bang algorithm and the continuous algorithm, Petitioner fails to show that Sanders discloses “selecting a collision avoidance algorithm” as required by claim 1.

In the Reply, Petitioner focuses on the disclosure in Sanders that purportedly shows Sanders “must choose between an ‘up’ and a ‘down’ algorithm when running the ‘continuous’ obstacle avoidance algorithm.” Pet. Reply 7. The Petition states the continuous algorithm determines “whether to maneuver up or down.” Pet. 22 (citing Ex. 1005, 76, 83). The Petition also references the up and down maneuvers as part of its contention that Sanders discloses selecting an obstacle avoidance algorithm. *See id.* at 23. Dr. Hansman offers testimony to the same effect. Ex. 1003 ¶ 107.

In order to support the contention in the Reply, Petitioner relies on Dr. Hansman’s deposition testimony “that ‘the algorithm which guides the up maneuver would or could be different from the algorithm that provides the [down] route.’” Pet. Reply 7 (citing Ex. 2010, 43:1–13). Dr. Hansman did not provide any testimony in his declaration that the up and down maneuvers in Sanders constitute separate collision avoidance algorithms. *See* Ex. 1003 ¶¶ 101–107. Further, neither Petitioner nor Dr. Hansman cites to any disclosure in Sanders to support this theory.

Dr. Kaputa testifies “a [skilled artisan] would not use the words maneuver and algorithm interchangeably. Indeed, not even Sanders does so and instead makes clear that a collision avoidance algorithm includes maneuvers.” Ex. 2011 ¶ 57 (citing Ex. 1005, 141 *et seq.*). Dr. Kaputa further testifies “a maneuver can be executed via an algorithm, however, in the case of Sanders there is a clear delineation between maneuvers and collision avoidance algorithms.” *Id.* Dr. Kaputa further testifies:

Sanders further states “Many collision avoidance algorithms in the literature seem to choose a maneuver direction with little thought of justification. As we will see, however, this decision can depend on many factors. Collision avoidance maneuvers usually fall into one of four categories: *horizontal maneuvers*, *vertical maneuvers*, *speed changes*, and *combination maneuvers*. EX. 1005 at 65 (emphasis in original). Further, “Most algorithms in the collision avoidance literature seem to use horizontal resolution maneuvers.” *Id.* at 65–66. Thus, it is clear that for a [skilled artisan], a collision avoidance maneuver is not a collision avoidance algorithm, rather it is an instruction contained within a higher level collision avoidance algorithm that may be performed under the right circumstances.

Id. ¶ 60.

Petitioner submits no evidence to rebut this testimony by Dr. Kaputa. Further, Dr. Kaputa’s testimony that a skilled artisan would understand that maneuvers are distinct from algorithms is consistent with Dr. Hansman’s declaration testimony. *See* Ex. 1003 ¶ 106 (testifying the “the continuous algorithm determines whether to maneuver up . . . or down”). In addition, Sanders discloses its continuous algorithm contains a step where it “Compute[s] collision avoidance maneuver.” Ex. 1005, 149. We, therefore, credit Dr. Kaputa’s testimony because it is based on corroborating evidence from Sanders over Dr. Hansman’s unsupported deposition testimony. To the extent that Petitioner contends that these maneuvers correspond to collision avoidance algorithms in the ’232 patent (Pet. Reply 8–9), Petitioner’s contention is not persuasive because it is attorney argument not supported by evidence. Consequently, Petitioner fails to establish with evidence that Sanders’ continuous algorithm choosing between an up or down maneuver satisfies the limitation “selecting a collision avoidance algorithm.”

There is an additional problem with Petitioner’s contention. Claim 1 provides “piloting the UAV, under control of a navigation computer, in

accordance with a navigation algorithm; while piloting the UAV: . . . selecting an obstacle avoidance algorithm.” Ex. 1001, 21:9–17. The recited sequence of steps requires selecting a collision avoidance algorithm while piloting the UAV in accordance with a navigation algorithm.

Petitioner provides the following annotated version of Figure 2.2 of Sanders:

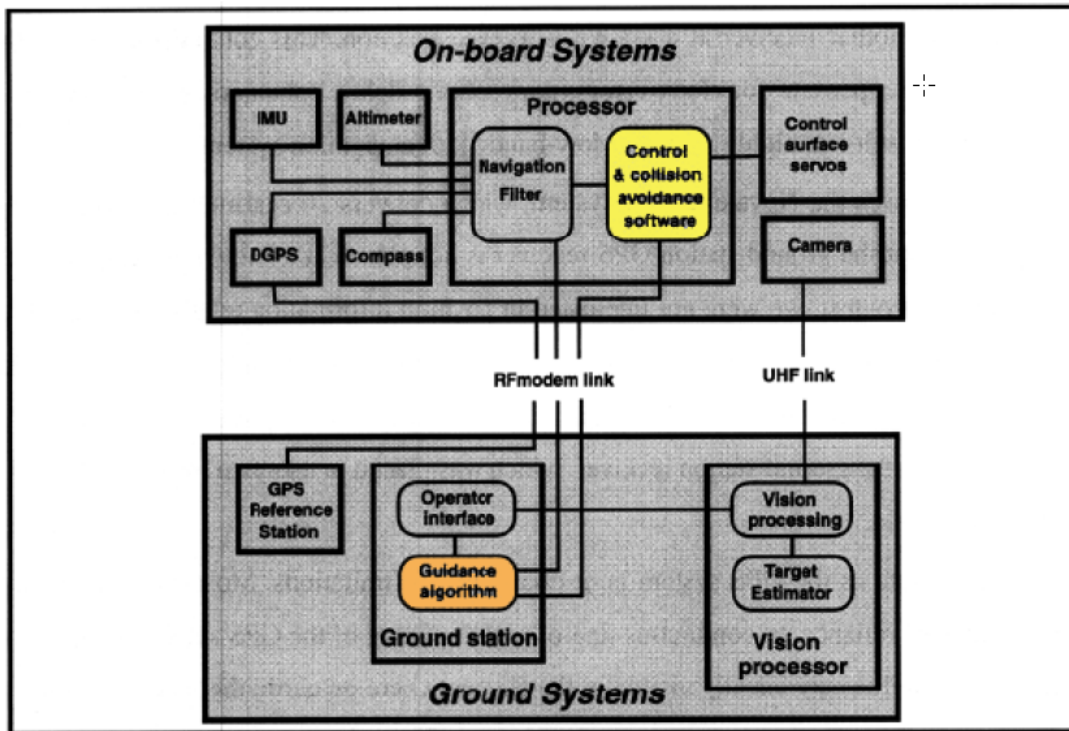


Figure 2.2: DSAAV system

Pet. 14. Figure 2.2 of Sanders is a block diagram with Ground Systems shown in a block on the bottom and Onboard Systems shown in a block on top. Petitioner highlights Sanders’s “Guidance algorithm” in orange in the bottom block and the “Control & collision avoidance software” in yellow in the top block. Petitioner contends “Sanders’ guidance system (shaded in orange in Figure 2.2 below) . . . is therefore the recited ‘navigation computer’ and the guidance algorithm is the recited ‘navigation algorithm.’” *Id.* at 13 (citing Ex. 1003 ¶ 84). Petitioner contends Sanders’ “control

system . . . ‘pilots’ the AAV ‘under control of a navigation computer, in accordance with a navigation algorithm.’” *Id.* at 14 (citing Ex. 1003 ¶¶ 84–86). Petitioner also contends Sanders discloses its “control and collision avoidance software on the AAV (shaded yellow).” *Id.* at 16–17. The Petition, thus, confirms that Sanders’ guidance algorithm is distinct from the obstacle avoidance algorithm.

In response to a question concerning the steps in claim 1 recited as being performed “while piloting the UAV,” Dr. Hansman testifies

A person of ordinary skill in the art would read this as, you’re piloting the UAV, so you’re flying it under some guidance algorithm. You continuously, while you’re doing that, are monitoring for obstacles through this process.

In the event that you do detect an obstacle and you select the obstacle avoidance algorithm, you would then – you basically selected to go to another control mode. So you selected to go to the algorithm to follow the guidance of the obstacle avoidance algorithm.

So implicitly, you switch – you continually pilot but you switch your piloting mode.

Ex. 2010, 94:8–22.

Dr. Hansman’s testimony confirms that claim 1 requires selecting the obstacle avoidance algorithm while the UAV is piloted in accordance with the navigation algorithm. The testimony further confirms that once the collision avoidance algorithm is selected, the UAV is no longer piloted in accordance with the navigation algorithm. Petitioner’s theory in the Reply is that Sanders’ continuous algorithm meets the selecting limitation in claim 1 by selecting an up or down maneuver. Petitioner, however, fails to provide persuasive evidence of how, when Sanders’ continuous algorithm selects between an up or a down maneuver, the UAV is being piloted “in accordance with the navigation algorithm.”

For all the foregoing reasons, Petitioner has not shown that Sanders discloses or teaches the limitation “selecting an obstacle avoidance algorithm.”

Consequently, we determine Petitioner fails to establish by a preponderance of the evidence that claim 1 of the '232 patent is unpatentable over Sanders.

Claim 13 is directed to “A computer program product for navigating a UAV” and recites various means plus function claim elements that appear to parallel the limitations of claim 1, including “means, recorded on the recording medium, for selecting an obstacle avoidance algorithm.” Ex. 1001, 22:44–61. Petitioner relies on the same disclosure from Sanders for this limitation as for claim 1. Pet. 28. Patent Owner relies on the same arguments for claim 13 as for claim 1. PO Resp. 34–41.

For the reasons discussed above for claim 1, we determine Petitioner fails to establish that claim 13 of the '232 patent is unpatentable over Sanders.

Claim 6 depends from claim 1 and claim 18 depends from claim 13. Ex. 1001, 21:53–58, 24:16–25. We reviewed Petitioner’s contentions and evidence cited for claims 6 and 18. Pet. 28–33. The contentions and evidence do not cure the deficiencies in claim 1 or claim 13 discussed above.

Consequently, we determine that Petitioner fails to establish that claim 6 and claim 18 of the '232 patent are unpatentable over Sanders.

E. Grounds 2, 3, and 4

Claims 2–5 depend from claim 1 and claims 14–17 depend from claim 13. Petitioner details the disclosure in Sanders, Pilley, Sutter, and Pappas that it contends corresponds to the limitations in claims 2–5 and 14–17 as well as reasons for combining Sanders with each of Pilley, Sutter, and

Pappas. Pet. 34–52. We reviewed Petitioner’s contentions as well as the evidence cited for these dependent claims and find it does not cure the deficiencies in claim 1 or claim 13 discussed above.

Consequently, we determine that Petitioner fails to establish that claims 2–5 and 14–17 of the ’232 patent are unpatentable over Sanders in combination with the other relied-upon prior art.

F. Ground 5: Obviousness over Duggan and Pilley

Petitioner contends that claims 1–3, 6, 13–15, and 18 are unpatentable over Duggan and Pilley. Pet. 61–81. In support thereof, Petitioner identifies the disclosures in Duggan and Pilley alleged to describe the subject matter in the challenged claims. *Id.* Additionally, Petitioner offers declaration testimony from Dr. Hansman. Ex. 1003 ¶¶ 224–326.

Patent Owner contends a skilled artisan would not have been motivated to combine Duggan and Pilley as proposed. PO Resp. 50–53.

We begin our analysis with a brief overview of Duggan and Pilley. We then address the parties’ respective contentions with respect to the challenged claims.

Duggan – Ex. 1012

Duggan discloses “a variable autonomy control system that enables a human to manage and operate a vehicle through interaction with a human-system interface.” Ex. 1012, 1:14–17. The embodiments disclosed in Duggan are described “in the context of an unmanned aerial vehicle (UAV).” *Id.* at 4:53–54. Duggan’s variable autonomy control system (VACS) provides for control of a UAV “from fully autonomous control to simplified manual flight control modes for enhanced real-time control.” *Id.* at 5:19–25. Duggan’s VACS comprises a ground station connected by a data link to a UAV. *Id.* at Fig. 6. Executive component 652 located on

airborne system interface 604 “process[es] commands and information received from command control component 606” and manages UAV components such as navigation 662, guidance 658, and autopilot 654. *Id.* at 15:64–66. Among the functions performed by Duggan’s system are autonomous ground collision avoidance and autonomous see-and-avoid air collision avoidance. *Id.* at 7:48–53, Fig. 1. Ground collision avoidance system 120 “provides an automated mechanism enabling the control system to avoid terrain” and air collision avoidance system 122 autonomously avoids collisions with other aircraft. *Id.* at 11:8–11, 43:12–17.

Pilley — Ex. 1010

Pilley is directed to a system for controlling surface and airborne traffic using GNSS¹²-based or GPS-based data. Ex. 1010, 4:11–14. Pilley’s system controls and manages the flow of traffic approaching and departing an airport as well as the flow of surface vehicles and taxiing aircraft. *Id.* at 4:24–27.

Pilley defines a dynamic zone around an aircraft that moves with the aircraft. *Id.* at 11:11–17, Fig. 4. Pilley performs a rough check for vehicles in the immediate vicinity and uses a detection algorithm that “project[s] the position of a vehicle ahead by an increment of Time(t) using the received vehicle velocity.” *Id.* at 94:1–4, 297:32–34, Fig. 10. If the distance between vehicles at projected distances is less than a safe distance, Pilley generates an alert of a potential collision. *Id.* at 94:8–21.

Claim 1

a. Preamble

¹² “GNSS” refers to the Global Navigation Satellite System. Ex. 1010, 3:38–39.

Petitioner contends “Duggan’s VACS segregates UAV control into two fundamental categories: flight control associated ‘with the aviation of the aircraft’ and flight management associated ‘with the mission plan (navigation tasking) for the aircraft.” Pet. 61 (citing Ex. 1012, 6:1–6). Based on this, Petitioner contends that “the combination of Duggan and Pilley discloses a ‘[a] method for navigating a UAV.’” *Id.* (citing Ex. 1003, ¶ 239) (alteration in original).

Patent Owner does not directly address Petitioner’s contentions or whether the preamble is limiting. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan discloses the subject matter of the preamble. We do not reach the question of whether the preamble is limiting because it is not necessary to our determination.

b. Piloting the UAV Under Control of a Navigation Computer, in Accordance with a Navigation Algorithm

Petitioner contends Duggan discloses “a baseline set of guidance laws” such as “waypoint guidance law 1134; and loiter guidance mode 1142.” Pet. 63 (citing Ex. 1012, 21:33–35, 51:58). Petitioner further contends “Duggan’s set of guidance laws collectively is the recited ‘navigation algorithm.’” *Id.* (citing Ex. 1003 ¶ 243). Petitioner further contends “Duggan’s guidance component ‘is responsible for generating autopilot commands that, when executed, achieve a particular guidance objective.’” *Id.* at 64 (citing Ex. 1012, 21:22–24). Petitioner further contends that “Duggan’s autopilot 654 . . . ‘receives flight control commands, processes the commands . . . and passes commands to actuator control component 668 and engine control component 666 as necessary for flight control execution.’” *Id.* (citing Ex. 1012, 16:9–14). According to Petitioner, “Duggan’s autopilot therefore pilots the UAV under control of

the guidance component (*‘navigation computer’*) in accordance with the guidance laws (*‘navigation algorithm’*.” *Id.* (citing Ex. 1003 ¶ 244).

Patent Owner does not squarely address Petitioner’s contentions. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan discloses this limitation.

c. Reading from a GPS receiver a sequence of GPS Data

Petitioner contends Duggan discloses that its flight control system can be configured to support a GPS receiver. Pet. 64 (citing Ex. 1012, 58:1–4, 17:39–44). Petitioner further contends Duggan’s navigation component 662 “facilitates the collection and provision of data pertaining to aircraft location.” *Id.* at 65 (citing Ex. 1012, 16:7–9, Fig. 6). Petitioner further contends that the information obtained by navigation component 662 is “used by the guidance functionality to aid in decision-making such as, but certainly not limited to, path-regulation.” *Id.* (citing Ex. 1012, 21:12–20). Petitioner further contends that “GPS data is continuously generated and ‘read’ by the navigation and guidance components to perform collision avoidance and flight management functions.” *Id.* (citing Ex. 1003 ¶ 248; Ex. 1012, 17:51–57, Fig. 8). Based on the foregoing, Petitioner contends that “Duggan’s systems *‘read[s] . . . a sequence of GPS data.’*” *Id.* (citing Ex. 1003 ¶¶ 248–249) (alterations in original).

Petitioner further contends “Pilley also uses GPS data for ‘position projections, coordinate conversions, zone detection, collision prediction, [and] runway incursion detection’ among other functions.” Pet. 66 (citing Ex. 1010, 7:33–35) (alteration in original). Petitioner further contends “Pilley teaches that ‘[c]ollision processing is performed **each second**, upon receipt of the FEV’s [fully equipped vehicle] GPS position and velocity data.’” *Id.* (citing Ex. 1010, 328:25–27) (alteration in original). Based on

the foregoing, Petitioner contends “Pilley’s system also ‘reads . . . a sequence of GPS data.’” *Id.* (citing Ex. 1003 ¶ 249) (alteration in original). Petitioner concludes that “the combined system of Duggan and Pilley discloses ‘reading from a GPS receiver a sequence of GPS data’” and “[b]ecause the reading function is performed continuously during flight (e.g., every second as disclosed by Pilley), the ‘reading’ functions occurs ‘while piloting the UAV.’” *Id.* at 66–67 (citing Ex. 1003 ¶¶ 245–249).

Patent Owner does not squarely address Petitioner’s contentions for this limitation. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan and Pilley disclose this limitation.

d. Anticipating a Future Position of the UAV in Dependence Upon the Sequence of GPS Data

Petitioner contends “Duggan’s ‘ground collision avoidance system (GCAS) provides an automated mechanism enabling the control system to avoid terrain.” Pet. 67 (citing Ex. 1012, 43:12–17). Petitioner further contends Duggan reads a vehicle’s position from GPS data and its’ “GCAS algorithm predicts a collision by generating a scan pattern that ‘starts at the vehicle position.’” *Id.* (citing Ex. 1012, 43:54–55). Petitioner further contends Duggan generates a horizontal uncertainty box and the GCAS algorithm calculates the maximum terrain altitude in each uncertainty box. *Id.* (citing Ex. 1012, 43:55–59, Fig. 23). Petitioner further contends the “GCAS algorithm next ‘assumes a constant initial velocity and **projects the trajectory** along the velocity line to estimate a time to fly up.’” *Id.* (citing Ex. 1012, 44:23–25). Petitioner further contends that “[i]n an embodiment, Pilley’s detection process is performed *onboard the aircraft*.” *Id.* at 56 (citing Ex. 1010, 93:47–52) (emphasis added). Petitioner further contends that “[t]he modified air collision avoidance component of the combined

system integrates Pilley’s GPS-based collision detection” and “Pilley teaches that collision detection performed on the vehicle ‘us[es] the current GPS data and the information stored in the vehicle database.’” *Id.* at 68 (citing Ex. 1010, 297:19–21) (alteration in original). Petitioner further contends that Pilley’s algorithm “performs . . . collision checking by projecting the aircraft’s position ahead at one second intervals.” *Id.* at 69 (citing Ex. 1010, 297:36–38). Petitioner further contends “the combined system of Duggan and Pilley discloses ‘*anticipating a future position of the UAV in dependence upon the sequence of GPS data.*’” *Id.* (citing Ex. 1003 ¶¶ 250–258); *see also id.* at 55–58 (detailing combination of Duggan and Pilley because “Duggan . . . does not provide details regarding its air collision detection. Pilley discloses air collision detection technique.”). According to Petitioner, “the combined system performs the ‘*anticipating*’ function ‘*while piloting the UAV*’ because “Pilley describes that its ‘[c]ollision processing is performed **each second**, upon receipt of the FEV’s GPS position and velocity data.’” *Id.* at 69 (citing Ex. 1003 ¶ 258; Ex. 1010, 328:25–27).

Patent Owner contends that Pilley’s “air collision avoidance is a ground control directed function” and “Pilley does not even report an embodiment in which the collision detection determination is reported on board an aircraft.” PO Resp. 49. In support of this contention, Patent Owner directs us to “Pilley’s Vehicle Functional Matrix” wherein, according to Patent Owner, “dynamic collision processing is not performed on aircraft. Instead, it is performed at the ground-based AC&M¹³ system, and on fully

¹³ “AC&M” refers to an Airport Control and Management System. Ex. 1010, 4:48.

equipped ground vehicles.” *Id.* (citing Ex. 1010, 325:25–53, 327:6–12, 328:20–35).

Petitioner, in turn, contends Pilley discloses that collision prediction would be on board the aircraft/vehicles. Pet. Reply 16–17 (citing Ex. 1010, 3:34–44; Ex. 1003 ¶ 230). Petitioner further contends “Pilley’s Vehicle Functional Matrix relates to ‘prototype demonstrations’ of ‘[t]hree vehicles, equipped with varying configurations of hardware and software.” *Id.* at 17 (citing Ex. 1010, 325:19–22) (alteration in original). Petitioner further contends the “prototypes are only a single example of Pilley’s disclosure.” *Id.* at 18.

For the following reasons, we are persuaded by Petitioner’s contentions.

First, we note the claims do not require performing collision detection on the aircraft. Second, Pilley’s Vehicle Functional Matrix relates to “prototype demonstrations” of “[t]hree vehicles, equipped with varying configurations of hardware and software.” Ex. 1010, 325:19–22. The matrix indicates that the aircraft used in the prototype demonstrations did not “Perform[] dynamic collision processing” but it also indicates that the aircraft did “Perform[] zone incursion processing.” *Id.* at 325:39–42. The description of the matrix does not suggest that Pilley’s system is limited to the specific details of the prototype vehicles. *See id.* at 325:15–327:33.

Pilley discloses that it anticipates its system is “capable of performing the navigation, surveillance, collision prediction, and zone/runway incursion . . . on the aircraft.” Ex. 1010, 3:41–42. Pilley further discloses dynamic zones around aircraft that move with the aircraft. *Id.* at 11:11–13, Fig. 4. The zones shown in Pilley’s Figure 10 are used in the collision detection system described in Pilley. *See id.* at 93:41–94:45, 297:16–63,

Fig. 10. Although the prototype demonstrations reported in the Vehicle Functional Matrix indicate that collision processing was not performed on board the aircraft, the disclosure just discussed suggests to a skilled artisan that Pilley contemplated equipping the aircraft with collision detection.

Although Petitioner's evidence supports a finding that Duggan and Pilley disclose this limitation, as discussed below in connection with Motivation to Combine, we find Petitioner has not established that a skilled artisan would have combined Duggan and Pilley as proposed in the Petition.

e. Identifying an Obstacle in Dependence Upon the Future Position

Petitioner contends "Duggan's GCAS algorithm 'provides the operator with some form of situational awareness information about an upcoming collision (e.g., a warning signal).'" Pet. 69 (citing Ex. 1012, 43:17–20). Petitioner further contends that "GCAS 'monitors vehicle altitude and ground altitude and attempts to **predict at what point the vehicle will intersect the terrain.**'" *Id.* (citing Ex. 1012, 44:1–3). Petitioner further contends the "air collision avoidance component" in Petitioner's proposed combination "determines whether the UAV is within a safe clearance distance of other vehicles at projected future positions" and "[w]hen the separation distance between the UAV and another vehicle is less than the safe clearance distance, a potential collision alert is generated." *Id.* at 70 (citing Ex. 1010, 94:8–14, 297:42–45). According to Petitioner, "the algorithm identifies whether the vehicle is an '*obstacle*' at a future position of the UAV." *Id.* (citing Ex. 1003 ¶ 261). Based on the foregoing, Petitioner contends that "the combination of Duggan and Pilley discloses '*identifying an obstacle in dependence upon the future position.*'" *Id.* (citing Ex. 1003 ¶¶ 259–261). According to Petitioner, the combined system

“perform[s] the ‘*identifying*’ function ‘*while piloting the UAV*’” because “Pilley describes that its ‘[c]ollision process is performed **each second**, upon receipt of the FEV’s GPS position and velocity data.’” *Id.* (citing Ex. 1003 ¶ 262; Ex. 1010, 328:25–27).

Patent Owner does not squarely address Petitioner’s contentions. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan and Pilley disclose this limitation.

f. Selecting an Obstacle Avoidance Algorithm

Petitioner contends that if Duggan detects terrain as an obstacle, “the system selects GCAS which provides an automated mechanism to avoid the terrain.” Pet. 70–71 (citing Ex. 1012, 43:13–15). Petitioner further contends “[i]f the obstacle is another vehicle, the system selects air collision avoidance,” which “override[s] the waypoint path and direct[s] the aircraft off of the collision course.” *Id.* at 71 (citing Ex. 1003 ¶ 264; Ex. 1012, 11:6–11). Based on the foregoing, Petitioner contends that “the combined system of Duggan and Pilley discloses ‘*selecting an obstacle avoidance algorithm*.’” *Id.* (citing Ex. 1003 ¶¶ 263–265) (alteration in original).

Patent Owner does not squarely address Petitioner’s contentions. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan and Pilley disclose this limitation.

g. Piloting the UAV in Accordance with the Selected Obstacle Avoidance Algorithm

Petitioner contends that both of Duggan’s GCAS and air collision avoidance components autonomously execute obstacle avoidance algorithms. Pet. 72. Petitioner contends that “[f]or ground collision avoidance, the system causes the autopilot to execute a vertical fly-up maneuver to ‘automatically avoid the terrain.’” *Id.* (citing Ex. 1012, 43:20–

23). Petitioner further contends that for air collisions, “Duggan’s collision avoidance commands ‘will first correspond to the requested waypoint path, then there will be a transition to a non-collision path, and then there will be a graceful transition back to the waypoint path.’” *Id.* at 71 (citing Ex. 1012, 11:11–15). Based on the foregoing, Petitioner contends “the combined system of Duggan and Pilley discloses ‘*piloting the UAV in accordance with the selected obstacle avoidance algorithm.*’” *Id.* at 72 (citing Ex. 1003 ¶¶ 266–268).

Patent Owner does not squarely address Petitioner’s contentions. *See* PO Resp. 46–53. Based on our review of the evidence cited by Petitioner, we find that Duggan and Pilley disclose this limitation.

h. Motivation to Combine

Petitioner contends a skilled artisan “would have been motivated to modify Duggan’s air collision avoidance component to integrate Pilley’s air collision detection processes.” Pet. 58 (citing Ex. 1003 ¶¶ 235–238).

Petitioner provides the following annotated version of Duggan’s Figure 1:

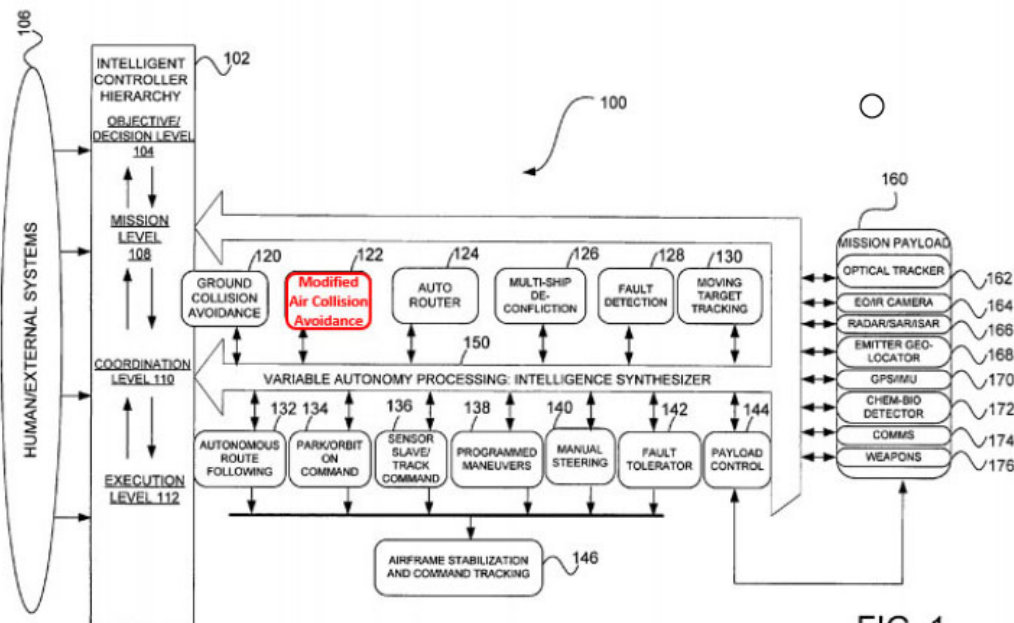


FIG. 1

Id. at 59. Figure 1 of Duggan is a block diagram illustrating Duggan's variable autonomy control system. Ex. 1012, 3:40–41. Petitioner highlights in red block 122 of Figure 1 illustrating what Petitioner terms “the modified air collision avoidance component module.” Pet. 58. Petitioner's proposed modification of Duggan is based on plugging the air collision avoidance module of Pilley into block 122 in accordance with “Duggan's plug-n-play VACS architecture.” *Id.* (citing Ex. 1012, 7:12–15, 8:57–61).

Petitioner provides several reasons why a skilled artisan would have purportedly integrated Pilley's air collision avoidance processes into Duggan. First, Petitioner contends “Duggan does not provide any details regarding the mechanism used to **detect** potential obstacles or collisions other than a brief mention of an optical tracker” and a skilled artisan would therefore “look for references disclosing details of air collision detection techniques and would have been led to Pilley.” Pet. 59 (citing Ex. 1003 ¶ 236). Second, Petitioner contends a skilled artisan “would have been motivated to integrate GPS-based air collision detection into Duggan to provide an enhanced collision avoidance system that avoids problems of optical systems due to environmental conditions (e.g., clouds, fog, etc.).” *Id.* at 59–60 (citing Ex. 1003 ¶ 237). Petitioner further contends Pilley provides motivation for the combination by touting “the application of new technologies to the management of our airports [to] provide improved efficiency, enhanced safety.” *Id.* at 60 (citing Ex. 1010, 3:45–50). Third, Petitioner contends Duggan “stresses that collision avoidance ‘and other applicable functions are commercially available modules for integration’” and “can be integrated in a ‘plug-n-play’ format.” *Id.* at 60 (citing Ex. 1012, 7:12–15, 7:42–44, 8:57–61). Petitioner further contends it would have “been obvious to a [skilled artisan] to integrate modified or additional collision

avoidance capabilities to enhance the operation and safety of Duggan's system." *Id.* (citing Ex. 1003 ¶ 238).

Patent Owner contends that a skilled artisan would not have modified Duggan's control system as proposed because of the differences between Duggan's UAV collision avoidance process and Pilley's airport collision avoidance process. PO Resp. 46–50.

Patent Owner contends Duggan discloses "a variable autonomy control system that enables a human to manage and operate a vehicle [e.g., a UAV] through interaction with a human-system interface." PO Resp. 46 (citing Ex. 1012, 1:14–17, 4:53–54) (alteration in original). Patent Owner further contends Duggan's "variable autonomy control system (VACS) includes a ground station connected by a data link to a UAV." *Id.* (citing Ex. 1012, Fig. 6). Patent Owner further contends "Duggan distinguishes between UAV flight control and UAV flight management." *Id.* at 47 (citing Ex. 1012, 5:67–6:6). Patent Owner further contends that in Duggan, "mission control is a UAV autonomous function" and air collision avoidance is part of Duggan's mission control. *Id.* (citing Ex. 1012, 7:48–53, 9:34–41; Ex. 1020, 55:21–56:21; Ex. 2010, 56:22–57:22). According to Patent Owner, because air collision avoidance is a UAV autonomous function, "it is a decision that the UAV needs to make for itself based on what it perceives from its environment and what it has been programmed to view as a condition requiring some action." *Id.* (citing Ex. 2010, 57:16–22).

Patent Owner next contends "for Pilley, air collision avoidance is not an aircraft autonomous function." PO Resp. 48. According to Patent Owner, in Pilley, "surface (i.e., ground) vehicles and aircraft report their positions to a ground control station." *Id.* (citing Ex. 1010, 291:5 *et seq.*, Fig. 22). Patent Owner further contends "[b]oth the surface vehicles and

aircraft send Automatic Dependent Surveillance (ADS) messages to AC&M processor 115, which in turn composes air traffic control ('ATC') messages that are forwarded to the vehicles and aircraft.” *Id.* Patent Owner further contends Pilley’s “AC&M system uses information obtained from the ADS messages to construct a database containing the positions and movements of surface vehicles and aircraft” and the AC&M system uses this information to predict collisions. *Id.* (citing Ex. 1010, 9:32–39, 9:44–45). Patent Owner further contends “[t]he ATC messages are used to provide the vehicles and aircraft sufficient information to avoid such collisions.” *Id.* at 48–49 (citing Ex. 1010, 293:10–20, 293:42–45; Ex. 2010, 77:16–79:3). Based on this, Patent Owner asserts Pilley’s “air collision avoidance is a ground control directed function.” *Id.* at 49.

Patent Owner next contends a skilled artisan would not have been motivated “to implement the teachings of Pilley regarding a ground control directed collision avoidance system in a system such as that described in Duggan where collision avoidance is required to be a function a UAV performs itself” because “[r]elying on a ground station for direction concerning collision avoidance changes the principle of operation . . . of Duggan because a UAV would no longer be self-reliant for collision avoidance decisions.” PO Resp. 50 (citing Ex. 2011 ¶¶ 72, 74, 76–78). Patent Owner further contends relying on inputs from other aircraft to make collision avoidance decisions “opens the UAV to spoofing and rather than avoiding collisions, may in fact lead to collisions if false information is provided.” *Id.* at 51 (citing Ex. 2017, 2–20).

Patent Owner next contends “Sanders describes the dangers associated with adopting just any collision avoidance system, especially one which requires cooperation of other aircraft: incorrect assumptions may lead to

collisions.” PO Resp. 51 (citing Ex. 1005, 76). Patent Owner further contends that Petitioner proposed such a cooperative system where “all vehicles rely on the others sending information to a central controller and executing commands issued by a central controller,” which Patent Owner asserts “eliminates an autonomous see-and-avoid system that Duggan advocates for its collision avoidance system and which others deemed necessary.” *Id.* (citing Ex. 1012, 7:48–53; Ex. 2017, 2–3).

Petitioner, in turn, contends Patent Owner’s arguments are based on “a faulty premise” that “Pilley only discloses relying on a ground station for collision avoidance” because “it also discloses onboard collision prediction.” Pet. Reply 18–19; *see also id.* at 16–18 (arguing Pilley discloses collision prediction onboard aircraft). Petitioner next contends Patent Owner has no basis “to support its conclusory allegation that Duggan’s principle of operation is ‘self-relian[ce]’” because, according to Petitioner, “Duggan’s intent was to create a control system that could support ‘multiple levels of autonomous operation.’” *Id.* at 19 (citing Ex. 1012, 1:56–67). Petitioner next contends “Sanders does not teach away from the use of any and all cooperative systems. Sanders identified limitations with the specific bang-bang algorithm.” *Id.* at 20 (citing Ex. 1005, 78). According to Petitioner, Sanders “did not—and could not have—taught away from a system that was not actually disclosed until years later.” *Id.* (citing Ex. 1005, 1; Ex. 1012, code (22)).

For the following reasons, we determine that Petitioner has not established that a skilled artisan “would have been motivated to modify Duggan’s air collision avoidance component to integrate Pilley’s air collision detection processes.” Pet. 58.

First, Petitioner and Dr. Hansman rely heavily on Duggan’s disclosure that its VACS architecture is “plug-n-play.” Pet. 58; Ex. 1003 ¶ 238; *see also* Tr. 9:12–20 (arguing “how simple the combination would be”, “Duggan has designed such that additional components can be modularly plugged into the control architecture”, “Duggan talking about how things are just plug and play”). This argument appears to assume that a skilled artisan is an automaton and any modular collision avoidance system that could be plugged in would suffice for obviousness. However, the test for obviousness is not whether a skilled artisan *could* plug Pilley’s air collision detection process into Duggan but rather whether a skilled artisan *would* have done so. In that regard, Dr. Kaputa testifies to the “difference between creating a modular function that ‘plugs-n-plays’ with an intelligent synthesizer (as discussed by Duggan) and a component such as a GPS-based collision avoidance system that relies on zone databases constructed from time varying position and state information provided by other aircraft in the region.” Ex. 2011 ¶ 80. Among the reasons cited by Dr. Kaputa to support his opinion of a difference between Duggan and Pilley is a skilled artisan would “have to ensure that all aircraft flying within the vicinity of the UAV also adhere, subscribe, and transmit data to the new GPS-based collision avoidance system in order for it to be effective.” *Id.* (citing Ex. 1010, 93:41–94:60); *see also* Ex. 1005, 76 (“It is especially important for each vehicle’s CAS to know whether the other vehicle are cooperating with them in collision avoidance.”).

Second, Patent Owner provides evidence concerning see-and-avoid collision avoidance requirements for a UAV as required in Duggan (Ex. 1012, 7:47–50). Patent Owner directs us to Exhibit 2017, which is titled “Issues Concerning Integration of Unmanned Aerial Vehicles in Civil

Airspace.” Ex. 2017, cover (“DeGarmo”). In particular, DeGarmo discusses see-and-avoid collision avoidance for UAVs and points to different requirements for see-and-avoid collision avoidance requirements in manned vs. unmanned vehicles. *Id.* at 2–3. DeGarmo discloses:

To avoid collisions, UAV’s must have a “see and avoid” capability . . . that allows them to detect and safely steer clear of aircraft or other obstructions. The pilot’s responsibilities in see-and-avoid activities in manned aircraft are spelled out in FAA Advisory circular 90-48C, *Pilot’s Role in Collision Avoidance*. For UAVs, FAA directive 7610.4J, entitled *Special Military Operations*, states that the UAV (referred to as “ROAs” in the directive) operations require “the proponent to provide the ROA with a method that provides an equivalent level of safety, comparable to see-and-avoid requirements for manned aircraft.” This in essence, ties it to AC90-48C. Further, FAR Part 91.113, *Right of Way Rules*, states that: “regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft as to see and avoid other aircraft.” To satisfy the requirements, all UAVs must therefore be able to reliably avoid collisions with *all* aircraft—cooperative and non-cooperative—at *all* times.

Id. (footnote omitted).

DeGarmo discloses that UAVs are essentially tethered to ground-based links that “are used for vehicle control, monitoring, and air traffic communications and are, to varying degrees vulnerable to jamming, spoofing, and interference or attempts to usurp control.” Ex. 2017, 2–20. Sanders, like DeGarmo, refers to the need for cooperative communication between UAVs to avoid collisions. Ex. 1005, 76.

Petitioner fails to address in the Petitioner Reply the distinction in the FAA see-and-avoid requirements for manned and unmanned vehicles discussed in DeGarmo. *See* Pet. Reply 16–20. With respect to Sanders, Petitioner argues that “Sanders does not teach away from the use of any and

all cooperative systems.” *Id.* at 20. Patent Owner, however, does not argue that Sanders teaches away from using cooperative communications. Rather, based on our review of Sanders, we find that Sanders corroborates, in part, the reasons why DeGarmo’s teachings undercut Petitioner’s reasons for plugging Pilley’s collision avoidance processing into Duggan’s architecture. Ex. 1005, 76.

Petitioner focuses much of its Reply on the fact that Pilley teaches it contemplates putting its collision avoidance system on an aircraft. Pet. Reply 16–19. Petitioner, however, does not direct us to any disclosure in Pilley that it intended its collision avoidance system to be used on a UAV.¹⁴ *See generally* Pet.; Pet. Reply; Tr. 11:7–11. Further, Petitioner fails to provide persuasive evidence that Pilley’s manned vehicle collision avoidance system wherein, as disclosed in DeGarmo, the pilot plays a role in see-and-avoid collision avoidance, would provide an equivalent level of safety in an unmanned UAV as required by the FAA requirements referenced in DeGarmo (Ex. 2017, 2–3). Given the distinction between see-and-avoid collision requirements in UAVs as opposed to manned aircraft as disclosed in DeGarmo, Petitioner does not persuade us that a skilled artisan would have simply plugged Pilley’s collision avoidance processing into Duggan’s architecture.

For all the foregoing reasons, we determine Petitioner fails to establish that claim 1 of the ’232 patent is unpatentable over Duggan and Pilley.

¹⁴ Petitioner does not assert that it would have been obvious to modify Pilley’s collision avoidance processing for use in a UAV.

Claim 13

Claim 13 recites “A computer program product for navigating a UAV” in the form of various means plus function claim elements that appear to parallel the limitations of claim 1. Ex. 1001, 22:44–61.

Petitioner relies on the same combination of Duggan and Pilley as for claim 1. Pet. 73.

For the reasons discussed in connection with claim 1, we determine Petitioner fails to establish that claim 13 of the ’232 patent is unpatentable over Duggan and Pilley.

Claims 2, 3, 6, 14, 15, and 18

Claims 2, 3, and 6 depend from claim 1 and claims 14, 15, and 18 depend from claim 13. Petitioner details the disclosure in Duggan and Pilley that it contends corresponds to the limitations in claims 2, 3, 6, 14, 15, and 18. Pet. 75–81.

We reviewed Petitioner’s contentions as well as the evidence cited for these dependent claims and find it does not cure the deficiencies in claim 1 or claim 13 discussed above.

Consequently, we determine that Petitioner fails to establish that claims 2, 3, 6, 14, 15, and 18 of the ’232 patent are unpatentable over Duggan and Pilley.

G. Ground 6: Obviousness over Duggan, Pilley, and Sainthuile

Claims 4 and 5 depend from claim 1 and claims 16 and 17 depend from claim 13. Petitioner details the disclosure in Duggan, Pilley, and Sainthuile that it contends corresponds to the limitations in claims 4, 5, 16, and 17, as well as reasons for combining Duggan, Pilley, and Sainthuile. Pet. 81–90.

We reviewed Petitioner's contentions as well as the evidence cited for these dependent claims and find it does not cure the deficiencies in claim 1 or claim 13 discussed above.

Consequently, we determine that Petitioner fails to establish that claims 4, 5, 6, 14, 15, and 18 of the '232 patent are unpatentable over Duggan and Pilley.

III. CONCLUSION

Based on the record before us, we determine the following:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1, 6, 13, 18	103(a)	Sanders		1, 6, 13, 18
2, 14	103(a)	Sanders, Pilley		2, 14
3, 15	103(a)	Sanders, Suiter		3, 15
2, 5, 16, 17	103(a)	Sanders, Pappas		2, 5, 16, 17
1–3, 6, 13–15, 18	103(a)	Duggan, Pilley		1–3, 6, 13–15, 18
4, 5, 16, 17	103(a)	Duggan, Pilley, Sainthuile		4, 5, 16, 17
Overall Outcome				1–6, 13–18

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, based on the preponderance of the evidence, claims 1–6 and 13–18 of the '232 patent have not been shown to be unpatentable; and

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

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