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Paper 48
Entered: November 10, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT &
BMW OF NORTH AMERICA, LLC,
Petitioner,

v.

PAICE LLC & THE ABELL FOUNDATION, INC.,
Patent Owner.

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IPR2020-00994
Patent 7,104,347 B2

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Before SALLY C. MEDLEY, KALYAN K. DESHPANDE, and ARTHUR M. PESLAK, *Administrative Patent Judges.*

PESLAK, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
*35 U.S.C. § 318(a); 37 C.F.R. § 42.71*
Denying-in-Part and Dismissing-in-Part Petitioner's Motion to Exclude
*37 C.F.R. § 42.64*

# I. INTRODUCTION

Bayerische Motoren Werke Aktiengesellschaft and BMW of North America, LLC (collectively "Petitioner" or "BMW") filed a Petition (Paper 1) and, with our permission, filed a Corrected Petition (Paper 11, "Pet.") requesting an *inter partes* review of claims 2, 11, 17, 24, 33, and 38 of U.S. Patent 7,104,347 B2 (Ex. 1001, "the '347 patent"). Petitioner submitted the Declaration of Dr. Gregory W. Davis in support of the Petition. Ex. 1008 ("Davis Decl."). Paice LLC and the Abell Foundation, Inc. (collectively "Patent Owner" or "Paice") filed a Preliminary Response (Paper 13, "Prelim. Resp."). Taking into account the arguments presented in Patent Owner's Preliminary Response, we determined that there was a reasonable likelihood that Petitioner would prevail in its contention that at least one of the challenged claims of the '347 patent is unpatentable under 35 U.S.C. § 103(a). On November 19, 2020, we instituted *inter partes* review as to the challenged claims and all grounds presented in the Petition. Paper 19. ("Dec.").

During the course of trial, Patent Owner filed a Patent Owner Response. Paper 22. ("PO Resp."). Patent Owner also filed a Declaration of Dr. Mahdi Shahbakhti in support of its response. Ex. 2016 ("Shahbakhti Decl."). Petitioner filed a Reply to Patent Owner's Response. Paper 28 ("Pet. Reply"). In support of its Reply, Petitioner submitted a Reply Declaration of Dr. Gregory W. Davis. Ex. 1088 ("Davis Reply Decl.). Patent Owner filed a Sur-reply. Paper 34 ("Sur-reply"). An oral hearing was held on August 25, 2021 and a transcript of the hearing has been entered into the record. Paper 47 ("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 '347 patent. For the reasons discussed below, we determine Petitioner establishes by a preponderance of the evidence that claims 2, 11, 17, 24, 33, and 38 of the '347 patent are unpatentable.

### *A. Related Matters*

The '347 patent is currently at issue in *Paice LLC v. Bayerische Motoren Werke Aktiengesellschaft*, 1:19-cv-03348-SAG (D. Md.). Paper 4, 2. The '347 patent was subject to review in IPR2014-00571, IPR2014-00579, IPR2014-00884, IPR2015-00794, IPR2015-00795, IPR2017-00227, IPR2017-00226, and IPR2016-00272. Pet. 72–73. Final Written Decisions were issued in IPR2014-00571, IPR2014-00579, IPR2014-00884, IPR2015-00794, and IPR2015-00795. Ex. 1003; Ex. 1004; Ex. 1006; Ex. 1010. The Federal Circuit affirmed the Board's Final Written Decisions. Ex. 1005; Ex. 1007.

### *B. Real Parties in Interest*

Petitioner and Patent Owner state that the named entities are the only real parties in interest. Pet. 72; Paper 4, 2.

### *C. The '347 Patent (Ex. 1001)*

The '347 patent issued on September 12, 2006, and is titled "Hybrid Vehicles." Ex. 1001, codes (45), (54). The '347 patent issued from U.S. Patent Application 10/382,577 filed March 7, 2003. *Id.* at codes (21), (22).

The '347 patent is directed to hybrid vehicles comprising an internal combustion engine, a traction motor, and a battery bank and are controlled by a microprocessor so that the engine runs only under high efficiency conditions in response to the vehicle's torque requirements. *Id.* at code (57).

Figure 4 of the ’347 patent, reproduced below, illustrates the drive system of a hybrid vehicle:

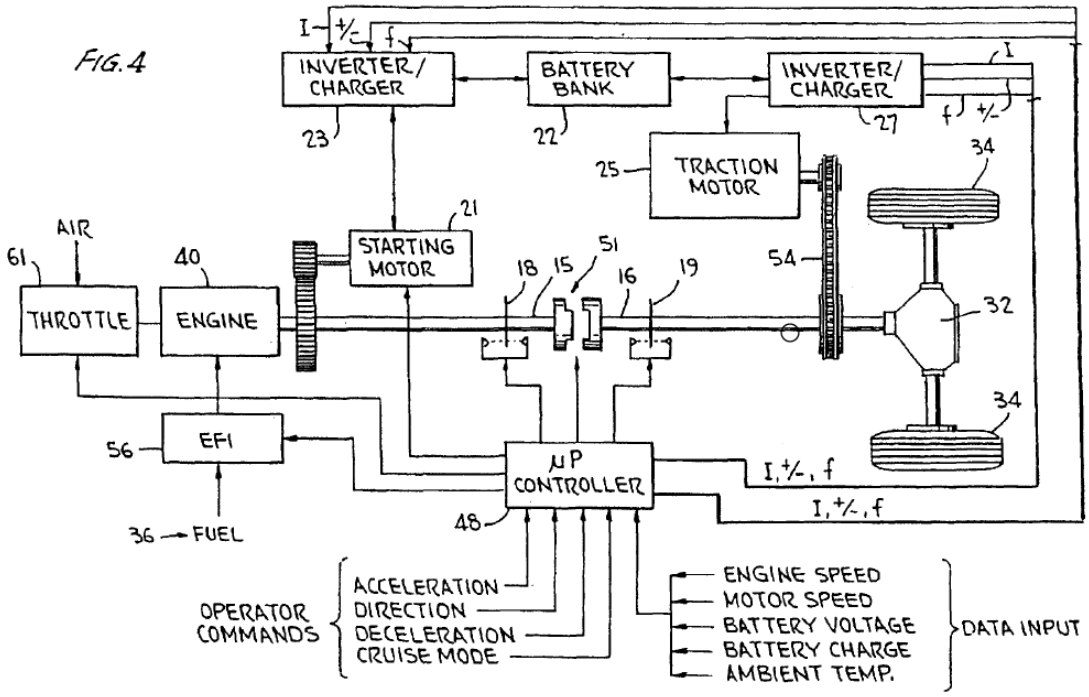


Figure 4 is “a block diagram of the principal components of the drive system” of an embodiment of the hybrid vehicle of the ’347 patent. *Id.* at 22:15–16. As shown in Figure 4, the drive system includes internal combustion engine 40, starting motor 21, traction motor 25, battery bank 22, and microprocessor 48. *Id.* at 17:5–45. The microprocessor features an engine control strategy that runs the engine only under conditions of high efficiency, typically when the vehicle’s instantaneous torque requirements (i.e., the amount of torque required to propel the vehicle, or “road load”) is at least equal to 30% of the engine’s maximum torque output (“MTO”) capability. *Id*. at 20:52–60, 35:5–14; *see also id*. at 13:47–61 (“the engine is never operated at less than 30% of MTO, and is thus never operated inefficiently.”).

Running the engine only when it is efficient to do so leads to improved fuel economy and reduced emissions. *Id*. at 13:47–51. To achieve such efficiency, the hybrid vehicle includes various operating modes that depend on the vehicle's torque requirements, the battery's state of charge, and other operating parameters. *Id*. at 19:53–55. For example, the hybrid vehicle may operate in: (1) an all-electric mode, where only the traction motor provides the torque to propel the vehicle and operation of the engine would be inefficient (i.e., stop-and-go city driving); (2) an engine-only mode, where only the engine provides the torque to propel the vehicle and the engine would run at an efficient level (i.e., highway cruising); (3) a dual-operation mode, where the traction motor provides additional torque to propel the vehicle beyond that already provided by the engine and the torque required to propel the vehicle exceeds the maximum torque output of the engine (i.e., while accelerating, passing, and climbing hills); and (4) a battery recharge mode where the engine operates a generator to recharge the battery while the traction motor drives the vehicle. *Id*. at 35:66–36:58, 37:26–38:55.

### *D. Prior Art and Asserted Grounds*

Petitioner asserts that claims 2, 11, 17, 24, 33, and 38 would have been unpatentable on the following grounds[1]:

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[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 103. Because the '347 patent was filed before the effective date of the relevant amendment, the pre-AIA version of § 103 applies.

| Claim(s) Challenged | 35 U.S.C. § | Reference(s)/Basis |
|---|---|---|
| 24 | 103(a) | Severinsky[2], Graf[3] |
| 33 | 103(a) | Severinsky, Ma[4] |
| 38 | 103(a) | Severinsky, Ehsani[5] |
| 2 | 103(a) | Severinsky, Ehsani, Graf |
| 11 | 103(a) | Severinsky, Ehsani, Ma |
| 17 | 103(a) | Severinsky, Ehsani |
| 24 | 103(a) | Severinsky, Nii[6] |
| 2 | 103(a) | Severinsky, Ehsani, Nii |
| 2, 24 | 103(a) | Bumby[7], Graf |
| 11, 33 | 103(a) | Bumby, Ma |
| 17, 38 | 103(a) | Bumby, Ehsani |

Pet. 9.

[2] US 5,343,970, issued Sept. 6, 1994 (Ex. 1013, "Severinsky").
[3] US 6,188,945 B1, issued Feb. 13, 2001 (Ex. 1020, "Graf").
[4] WO 92/15778, published Sept. 17, 1992 (Ex. 1021, "Ma").
[5] US 5,586,613, issued Dec. 24, 1996 (Ex.1019, "Ehsani").
[6] US 5,650,931, issued July 22, 1997 (Ex. 1022, "Nii").
[7] J.R. Bumby, *Computer modelling of the automotive energy requirements for internal combustion engine and battery electric-powered vehicles*, IEEE PROC., v. 132, pt. A, no. 5, 265–279 (Sep. 1985) (Ex. 1014 )("Bumby I"); J.R. Bumby and I. Forster, *Optimisation and control of a hybrid electric car*, IEE PROC., v. 134, pt. D, no. 6, 373–387 (Nov. 1987) (Ex. 1015) ("Bumby II"); I. Forster and J.R. Bumby, *A hybrid internal combustion engine/battery electric passenger car for petroleum displacement*, PROC. INST. MECH. ENGRS., v. 202, no. D1, 51–64 (Jan. 1988) (Ex. 1016) ("Bumby III"); J.R. Bumby and P.W. Masding, *A Test-Bed Facility for Hybrid IC Engine-Battery Electric Road Vehicle Drive Trains*, TRANS. INST. MEAS. & CONT., v. 10, no. 2, 87–97 (Apr. 1988) (Ex. 1017)("Bumby IV"); P.W. Masding and J.R. Bumby, *Integrated microprocessor control of a hybrid i.c. engine/battery-electric automotive power train*, TRANS. INST. MEAS. & CONT., v. 12, no. 3, 128-146 (Jan. 1990) (Ex. 1018)("Bumby V")(collectively "Bumby").

*E. The Challenged Claims*

Petitioner challenges dependent claims 2, 11, 17, 24, 33, and 38. Pet. 1. Claims 1, 3–10, 14–16, 19–23, 25–30, 32, 36, 37, and 39–41 of the '347 patent were previously cancelled. Ex. 1001, 55–58. Each of the challenged claims depends directly or indirectly from independent claim 1 or independent claim 23 which have both been cancelled. *Id.* at 58:12–62:52.

Claim 1 is directed to a hybrid vehicle requiring, *inter alia*, an internal combustion engine, a first electric motor, a second electric motor, a battery, and a controller operating the engine and motors according to a setpoint (SP). *Id.* at 58:13–37. The Board previously determined Claim 1 was unpatentable over Severinsky and Ehsani and over Bumby alone. Pet. 4–5 (citing Ex. 1003 (FWD in IPR2014-00571); Ex. 1004 (FWD in IPR2014-00579)). Claim 23 is directed to a method of control of a hybrid vehicle comprising elements similar to claim 1. Ex. 1001, 60:22–52. The Board previously determined Claim 23 was unpatentable over Severinsky alone and over Bumby alone. Pet. 4–5 (citing Ex. 1003; Ex. 1004).

Claim 2 requires that the controller "monitors patterns of vehicle operation over time and varies said setpoint SP accordingly." Ex. 1001, 58:38–40. Claim 24 contains limitations substantively similar to claim 2. *Id.* at 60:55–57. Claims 11 and 33 require, *inter alia*, a turbocharger coupled to the internal combustion engine. *Id.* at 59:30–39, 61:52–62:8. Claim 17 requires that the engine and one electric motor are coupled to a first set of wheels and the second electric motor is coupled to a second set of wheels. *Id.* at 59:64–67. Claim 38 requires a clutch and control of the speeds of the output shafts of the engine/motors to be substantially equal when the clutch is engaged. *Id.* at 62:29–37.

## II. ANALYSIS

### *A. Overview*

Petitioner bears the burden of establishing the unpatentability of any claim by a preponderance of the evidence. 35 U.S.C. § 316 (e); 37 C.F.R. § 42.1(d). 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).

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).[8] *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 "a graduate degree in mechanical, electrical or automotive engineering with at least some experience in the design and control of combustion engines, electric or hybrid electric propulsion systems, or design and control of automotive

[8] The parties have not offered evidence concerning objective indicia of non-obviousness.

transmissions." Pet. 5. Petitioner alternately contends that a skilled artisan would have "a bachelor's degree in mechanical, electrical or automotive engineering and at least five years of experience in the design of combustion engines, electric vehicle propulsion systems, or automotive transmissions." *Id.* (citing Ex. 1008 ¶¶ 43–46). Patent Owner does not address the level of ordinary skill in the art in the Patent Owner Response. *See generally* PO Resp.

We apply Petitioner's level of ordinary skill in the art because it appears consistent with the problems addressed in the '347 patent and the prior art of record.

### *C. Claim Construction*

Petitioner submits that three claim terms were construed by the Board in prior *inter partes* reviews of the '347 patent and that those constructions were affirmed by the Federal Circuit on appeal. Pet. 6–7 (citing Ex. 1003, 8, 11; Ex. 1004, 8, 11; Ex. 1005; Ex. 1011, 13). The terms and the previous constructions are as follows:

> 1) "road load" or "RL" as "amount of instantaneous torque required for propulsion of the vehicle"; 2) "setpoint" or "SP" as "a predefined torque value that may or may not be reset"; and 3) "monitoring patterns of vehicle operation over time" as "monitoring a driver's repeated driving operations over time."

Patent Owner does not dispute these constructions or request that we construe any other terms. PO Resp. 27. Therefore, we apply these claim constructions in this Decision.

### *D. Claim 24-Alleged Obviousness over Severinsky and Nii*

Claim 24 depends from claim 23 and recites "the further step of employing said controller to monitor patterns of vehicle operation over time and vary said setpoint SP accordingly." Ex. 1001, 60:55–57. The Board previously determined that claim 23 was unpatentable over Severinsky. Ex. 1003, 13–22.

#### *1. Overview of Severinsky–Exhibit 1013*

Severinsky discloses a hybrid electric vehicle comprising an internal combustion engine, an electric motor, and a battery. Ex. 1013, code (57). Both the electric motor and engine provide torque to drive the vehicle wheels. *Id.* The electric motor alone, using power stored in the battery, drives the vehicle at low speeds or in traffic. *Id.* During acceleration and hill climbing, both the electric motor and the engine drive the vehicle. *Id.* During steady state highway driving, the internal combustion engine alone drives the vehicle. *Id.*

#### *2. Overview of Nii – Exhibit 1022*

Nii relates to "a generator output controller for an electric vehicle having a generator mounted in addition to a battery." Ex. 1022, 1:7–9. Nii discloses a "travel pattern recognition means for recognizing travel repeated in accordance with a specific pattern." *Id.* at 2:4–5. Nii provides examples of a travel pattern "as people commuting using a standard vehicle, taking people to and from their offices using a commercial vehicle." *Id.* at 5:61–64. Nii discloses that "the output of a generator is set to a generator output equal to the power consumption value corresponding to the travel pattern in the case of traveling according to a travel pattern." *Id.* at 2:13–16. Using

the travel patterns makes it "possible to minimize power generation." *Id.* at 2:24.

*3. Analysis*

*i. Petitioner's Contentions*

Petitioner provides a claim chart detailing the Board's prior findings that independent claim 23 is unpatentable over Severinsky. Pet. 17–19. Patent Owner does not dispute any of Petitioner's contentions concerning claim 23. PO Resp. 41–47.

Pertinent to our analysis of claim 24, we note that Severinsky discloses that its "internal combustion engine is run only in the near vicinity of its most efficient operational point, that is, such that it produces 60%–90% of its maximum torque whenever operated." Ex. 1013, 20:63–67; Pet. 16. The Board previously found the lower limit of this torque range, is "a 'lower level' setpoint" as recited in claim 23. BMW 1003, 17. Claim 23 recites employing the electric motor to propel the vehicle when "the instantaneous torque RL required to propel the vehicle . . . is less than said lower level SP," employing the engine to propel the vehicle "when the torque RL required to do so is between said lower level [setpoint] and MTO[9]," and employing both the engine and electric motor to propel the vehicle when the torque RL "is more than MTO." Ex. 1001, 60:33–49.

Petitioner contends Severinsky discloses "a 'speed-responsive hysteresis' in certain circumstances in performing its mode switching." Pet. 20 (citing Ex. 1013, 18:34–42). Petitioner further contends "Severinsky

[9] "MTO" refers to maximum torque output of the engine. Ex. 1001, 60:25.

teaches that the vehicle 'will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30-35 mph.'" *Id.* (citing Ex. 1013, 18:36–38). Petitioner further contends that Severinsky employs hysteresis during deceleration and "Severinsky continues to run the engine unless the 'speed is reduced to 20-25 mph for a period of time, typically 2-3 minutes.'" *Id.* (citing Ex. 1013, 18:36–40). According to Petitioner, "[u]se of the 'speed-responsive hysteresis' requires 'var[ying] said setpoint accordingly' (from the setpoint if the hysteresis is not employed)." *Id.* (citing Ex. 1008 ¶ 404).

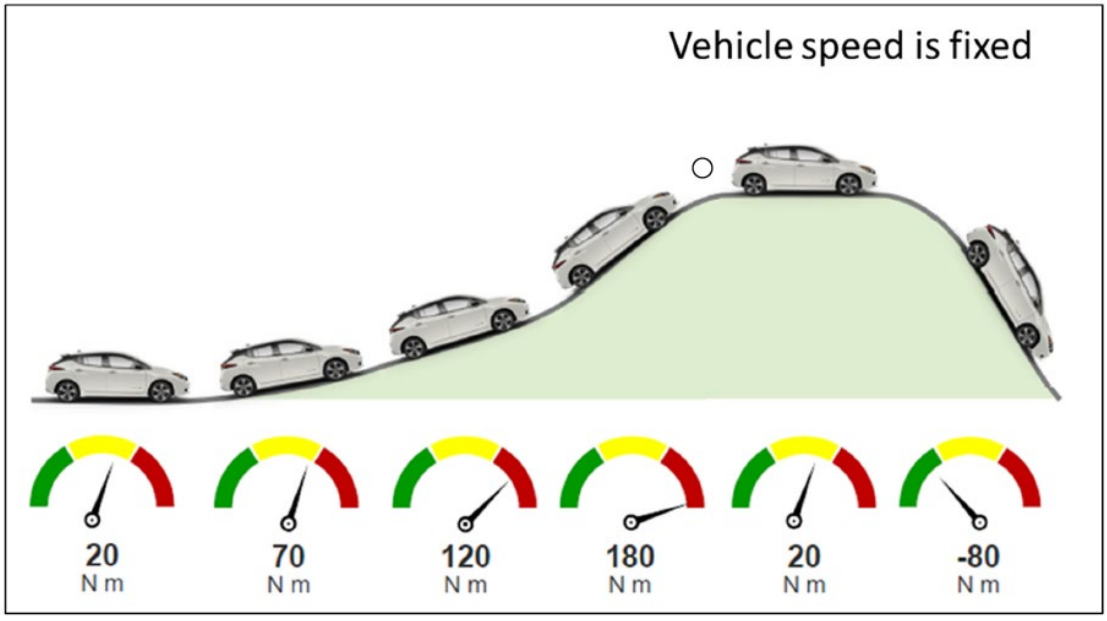
Petitioner turns to Nii for the requirement in claim 24 of "monitoring a driver's repeated driving operations over time." Pet. 45. Petitioner contends Nii's "controller stores and monitors patterns of vehicle operation over time, such as 'people commuting using a standard vehicle or taking people to and from their offices using a commercial vehicle" and Nii "describes 'recognizing a travel pattern when a [sic] travelling under the same condition is repeated a predetermined number of times or more.'" *Id.* at 44–45 (citing Ex. 1022, 2:4–5, 2:21–24, 3:7–9, 5:59–64, 6:43–51). Petitioner also contends Nii "stores travel patterns over time so that the 'target generator output becomes more accurate.'" *Id.* at 45 (citing Ex. 1022, 6:9–13). Petitioner further contends it would have been obvious "to use Nii's teachings of using a driver's repeated pattern of operation in order to also adjust the setpoint" of Severinsky in order to "further enhance the efficiency of Severinsky's use of hysteresis in . . . performing mode switching" and "to account for other special circumstances where it may be preferable to 'use the engine somewhat inefficiently rather than to discharge the batteries excessively,' or to avoid 'nuisance' starts and stops of the engine." *Id.* at 45–46 (citing Ex. 1008 ¶ 610; Ex. 1013, 18:23–42).

Petitioner further contends that a skilled artisan would have been motivated to vary Severinsky's engine setpoint by using Nii's pattern information rather than an arbitrary time period "in order to enhance the vehicle's efficiency including when employing hysteresis since the pattern information would be reflective of actual vehicle usage, rather than of arbitrarily-set parameters." *Id.* at 46 (citing Ex. 1008 ¶ 612). Petitioner further contends that a skilled artisan would have a reasonable expectation of success because incorporating Nii's pattern monitoring functioning into Severinsky's controller "would only require modifying Severinsky's logic to use the information reflecting the driver's repeated driving operations over time, rather than simply using arbitrarily-set parameters." *Id.* at 47–48 (citing Ex. 1008 ¶¶ 614–615).

*ii. Patent Owner's First Contention*

Patent Owner first contends "Severinsky's 'speed-responsive hysteresis' does not result in varying a speed- or torque-based setpoint." PO Resp. 18 (citing Pet. 20). Patent Owner argues that Severinsky's "speed-responsive hysteresis" mode "is simply a time-based hysteresis that adds a time delay ('2-3 minutes') to a speed threshold ('20-25 mph') for turning the engine off." *Id.* at 19 (citing Ex. 2016 ¶¶ 105–106). Patent Owner further contends this mode "maintains a ***fixed*** speed threshold and requires that the vehicle speed remain below the speed threshold for a predetermined amount of time" and a skilled artisan "would understand that the threshold would be written into source code and not change throughout the lifetime of the vehicle." *Id.* (citing Ex. 2016 ¶¶ 108–109). Patent Owner further contends that "there is no record evidence that the ***speed-***based time delay or the use of different ***speed*** thresholds for turning the engine on vs. turning the engine off would result in Severinsky 'varying said setpoint' which is a ***torque***

value." *Id.* (citing Ex. 2016 ¶¶ 112–115). Patent Owner further contends that a skilled artisan would understand Severinsky discloses two "separate control algorithms would operate in parallel: the speed-based algorithm (in which vehicle speed is the control variable) and the torque-based algorithm (in which road load is the control variable) both send signals to the controller to turn the engine on/off." *Id.* at 21 (citing Ex. 2016 ¶¶ 113-115). Patent Owner further contends that "[t]he physical relationship between speed and torque does not bridge the chasm between Severinsky's separate speed and torque-based algorithms" because "inasmuch as that speed may affect the torque required to propel the vehicle, vehicle speed and torque are both independent variables that do not vary proportionately under many conditions." *Id.* at 22 (citing Ex. 2016 ¶ 116). Patent Owner provides the following illustration of a vehicle traveling over a hill to support this contention:




The preceding image provided by Patent Owner shows a vehicle traveling from left to right from flat ground and then up and over a hill to illustrate

that "the instantaneous torque required to propel the vehicle varies with grade and has no dependence on speed." PO Resp. 23.

According to Patent Owner, "when the speed is low and the instantaneous torque is high . . . . a [skilled artisan] would understand that Severinsky would need to arbitrate between the speed-based algorithm and the torque-based algorithm by prioritizing one over the other", and that "Severinsky's decision to prioritize the 'speed-based hysteresis' algorithm simply results in disregarding the alleged torque-based setpoint (60% MTO), not varying it." *Id.* at 23–24 (citing Ex. 2016 ¶¶ 122–123).

Petitioner, in turn, contends that "Severinsky's engine will normally be operated above 60% MTO—i.e., the claimed '*setpoint'* . . . but Severinsky *also* teaches operating its engine 'outside its most fuel efficient operating range on occasion.'" Pet. Reply 8 (citing Dec. 23–24; Ex. 1013, 18:23–25). Petitioner contends that "Severinsky will '*vary said setpoint*' by lowering it below 60% MTO (which corresponds to 30–35 mph speed in 'highway mode') to avoid nuisance engine starts" and "Severinsky also discloses '*varying said setpoint*' in other non-hysteresis situations, such as to avoid discharging the batteries excessively." *Id.* (citing Dec. 32; Pet. 20, 46–47; Ex. 1013, 18:25–33; Ex. 1088 ¶¶ 9–10). Petitioner further contends Patent Owner's argument that Severinsky's hysteresis is speed-based only rather than a torque-based setpoint is "'a red herring'" because "Severinsky's control system does not take *only* speed into account—the Board debunked that argument years ago. . . but *must also* take torque into account." *Id.* (citing PO Resp. 20–23; Ex. 1003, 15–17; Ex. 1088 ¶¶ 8–26); *see also id.* at 11 (arguing that Patent Owner's arguments are precluded by determinations in prior *inter partes* review of '347 patent).

Petitioner next contends "[w]hile PO asserts that Severinsky's normal 30–35 mph/60% MTO 'threshold would be written into source code and would not change' . . . the challenged claims are agnostic as to how 'varying said setpoint' is accomplished." Pet. Reply 10 (citing Prelim. Resp. 18–20; Ex. 1088 ¶¶ 27–29). Petitioner contends both Severinsky and the '347 patent vary the setpoint during hysteresis in the same way. *Id.* (citing Ex. 1001, 41:10–54). According to Petitioner, "if the vehicle drops below the lower setpoint, *the engine will be shut off*," but "[t]he original setpoint is not disregarded but *replaced*—i.e., it is 'varied'—by a different (lower) setpoint corresponding to 20-25 mph during hysteresis, *as is confirmed in the '347 Patent*." *Id.* at 11 (citing Ex. 1001, 41:10–54; Ex. 1088 ¶ 30).

In the Sur-reply, Patent Owner contends that "Severinsky's choice to operate the engine below the 60% MTO setpoint does not mean that Severinsky varies the setpoint" rather it means "Severinsky operates the engine inefficiently in certain circumstances (*i.e.*, below 60% MTO)." Sur-reply, 4. Patent Owner further contends that Petitioner's "insinuation that Severinsky's controller 'switch[es] between two (or more) values that represent the 'setpoint' at any given time' is wrong" because, according to Patent Owner, "[t]here is no variation or dynamic 'switching' of the different thresholds to speak of." *Id.* at 5 (citing Reply 10, Ex. 2016 ¶¶ 110–111). Patent Owner further contends that "[t]he word 'accordingly' indicates that the 'controller' must vary the setpoint based on vehicle monitoring over time. BMW, however provides no evidence that Severinsky's controller selects between the engine on and engine off thresholds in ***real time***, much less based on observed vehicle operation." *Id.* at 6–7.

Patent Owner also contends that Petitioner's "assertions that 'Severinsky's speed-based thresholds correlate to torque-based thresholds' and 'speed thresholds' are also torque thresholds by their very nature' . . . are new arguments" and exceed the proper scope of a Reply. Paper 32, 2 (citing Reply 9–10); Sur-reply 8 n.6. Patent Owner contends the Petition "did not explain any relationship between 'speed thresholds' and 'torque thresholds.'" *Id.* Patent Owner makes similar arguments against "paragraphs 9–26 of Dr. Davis's reply declaration (Ex. 1088)" and Exhibits 1015, 1091, and 1092 that are referenced in Dr. Davis's reply declaration.

Petitioner responds that pages 9 and 10 of the Reply and paragraphs 9–26 of Dr. Davis's Reply

> directly rebut and respond to **(i)** the POR argument that Severinsky's hysteresis is only speed based while the "setpoint" claimed in the '347 Patent is "a torque value;" and **(ii)** the POR's acknowledgement of a "physical relationship between speed and torque," but argument that it "does not bridge the chasm between Severinsky's separate speed and torque-based algorithms.

Paper 33, 2 (citing PO Resp. 20–23). Petitioner further argues that Exhibit 1015 has been part of the record since the Petition was filed and "Exhibit 1092 contains omitted excerpts from a 2005 textbook that PO submitted with its POR as Exhibit 2020." *Id.*

For the following reasons, we are persuaded Severinsky teaches "vary[ing] said setpoint SP," as required by claim 24, during the hysteresis mode.

We first discuss the Board's prior findings in IPR2014-00571 to place in context the parties' contentions regarding the question of whether Severinsky's hysteresis mode is a speed based threshold only, as Patent Owner asserts, or is also a torque based threshold as Petitioner asserts.

Patent Owner is correct that the Board previously found Severinsky's 60% MTO corresponds to the lower level setpoint (SP) recited in claim 23. Ex. 1003, 17 (IPR2014-00571, Paper 44, 17 (PTAB Sept. 28, 2015)). In that case, Patent Owner made arguments that are substantially similar to the arguments it raises here. For example, the Board quoted Patent Owner that "Severinsky determines *when* to turn the engine on based on the speed of the vehicle in contrast to the '347 patent, which turns the engine on based on road load," "nowhere does Severinsky disclose that road load or any other torque demand is considered when determining when to employ the engine or if the road load is above the setpoint when the engine is operated," and "Severinsky 'uses speed as *the one factor* in determining whether to employ the engine.'" *Id.* at 15. In the face of these arguments, the Board found that "[a]lthough Severinsky describes the use of 'speed' as a factor considered by the microprocessor, Severinsky makes clear that the microprocessor also uses the vehicle's 'torque' requirements *in determining when to run the engine.*" *Id.* at 16 (citing Ex. 1013, 17:11–15) (emphasis added). In addition, the Board found that "torque and speed are not mutually exclusive concepts" and noted that the "'347 patent itself speaks of 'speed' when describing the vehicle's various operating modes." *Id.* at 18 (citing Ex. 1001, 17:34–37, 19:35–36).

We now turn to Patent Owner's contentions that Petitioner exceeds the proper scope of a reply. Petitioner "may not submit new evidence or argument in reply that it could have presented earlier" but "may submit rebuttal evidence in support of its reply." Consolidated Trial Practice Guide ("Consol. TPG"), 73 (Nov. 2019). In this case, Patent Owner specifically argues that Severinsky's hysteresis mode is speed-based not torque-based. *See* PO Resp. 20 ("there is no record evidence that the ***speed***-based timed

delay . . . would result in Severinsky 'varying said setpoint,' which is a ***torque*** value."). Thus, we agree with Petitioner that its Reply at pages 9–10 and paragraphs 9–26 of Dr. Davis's Reply Declaration directly respond to the issue raised by Patent Owner concerning whether Severinsky's hysteresis mode results in varying a torque-based setpoint.[10] In addition, in our Decision on Institution, we referenced the Board's extensive discussion in IPR2014–0571 of the relationship between torque and speed in Severinsky's control system. Dec. 31–32. Our Trial Practice Guide also allows Petitioner's Reply to address "issues discussed in the institution decision." Consol. TPG at 79. Therefore, to the extent necessary, we consider the arguments in Petitioner's Reply as well as paragraphs 9 to 26 of Dr. Davis's Reply Declaration and the exhibits referenced therein.

Patent Owner provides numerous arguments why Severinsky's hysteresis mode is speed-based rather than torque-based. However, Patent Owner never directly reconciles those arguments with the Board's finding in IPR2014–00571 that Severinsky's microprocessor considers both speed and torque when determining whether to run the engine. Ex. 1003, 16; *see also* Pet. Reply 8 ("Severinsky's control system does not take *only* speed into account—the Board debunked that argument years ago . . . but *must also* take torque into account.") (citing Ex. 1003, 15–17; Ex. 1088 ¶¶ 8–26). In fact, Patent Owner and Dr. Shahbakhti both acknowledge "speed may affect the torque required to propel the vehicle." PO Resp. 22; Ex. 2016 ¶ 116. Further, Patent Owner relies on Dr. Shahbahkti's testimony that

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[10] We note that Patent Owner deposed Dr. Davis and questioned him on his Reply Declaration. *See e.g.* Ex. 2029, 31:4–5.

Severinsky's controller considers both speed *and* torque in connection with his diagram illustrating the torque required to propel a vehicle over a hill at constant speed. PO Resp. 23 (citing Ex. 2016 ¶ 122) ("when the speed is low and the instantaneous torque is high . . . a POSA would understand that Severinsky would need to arbitrate between the speed-based algorithm and the torque-based algorithm by prioritizing one over the other."). According to Patent Owner, "Severinsky's decision to prioritize the 'speed-based hysteresis' algorithm simply results in *disregarding* the alleged torque-based setpoint (60% MTO), *not varying it*." *Id.* at 24 (citing Ex. 2016 ¶ 123) (emphasis added); *see also id.* at 21–23 ("the controller is merely disregarding the 60% MTO setpoint, not varying it.").

The primary basis for Patent Owner's argument that disregarding the MTO setpoint does not correspond to "varying" the setpoint as required by claim 24 is that Severinsky's setpoints "would be written into source code and not change throughout the lifetime of the vehicle." PO. Resp. 19; *see also* Sur-reply, 5 ("no variation or dynamic 'switching' of the different thresholds to speak of"). However, we agree with Petitioner that "the challenged claims are agnostic as to how 'varying said setpoint' is accomplished . . . They do not preclude switching between two (or more) values that represent the 'setpoint' at any given time as is done during Severinsky's hysteresis." Pet. Reply 10 (citing Ex. 1008 ¶¶ 27–28).

> Petitioner's contention is supported by Dr. Davis who testifies that:
>
> The claims do not require that "*varying said setpoint*" must be accomplished by changing a single variable in the source code that represents the claimed "setpoint." Nor do they preclude "*varying said setpoint*" by switching between two (or more) separate variables (or fixed values) that represent the "setpoint" at any given time depending on the circumstances during operation, as is the case with the standard

> engine on mode (60% MTO) and the lower value during the highway hysteresis mode (lower MTO %) thresholds in Severinsky.

Ex. 1088 ¶ 28. Dr. Davis' testimony is consistent with Patent Owner's position and Dr. Shahbakhti's testimony that Severinsky's controller must consider both speed and torque. *See* PO Resp. 23 (citing Ex. 2016 ¶ 122) (arguing that a skilled artisan "would understand that Severinsky would need to arbitrate between the speed-based algorithm and the torque-based algorithm by prioritizing one over the other.").

Dr. Davis also testifies that "Severinsky further teaches that the vehicle 'will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30-35 mph . . . Use of the 'speed responsive hysteresis' requires 'var[ying] said setpoint accordingly' (from the setpoint if the hysteresis is not employed)." Ex. 1008 ¶ 404 (citing Ex. 1013, 18:36–40). In response to Patent Owner's argument that Severinsky's hysteresis mode is speed-based, Dr. Davis credibly testifies that "when hysteresis is not being employed, the 'setpoint' in Severinsky for engine operation is 60% MTO; when hysteresis is being employed, that setpoint becomes a lower percentage MTO to minimize engine starts." Ex. 1088 ¶ 28. Dr. Davis supports this testimony that the claimed setpoint can be varied in this manner by citing to the discussion of varying setpoints during hysteresis in the '347 patent. *Id.* (citing Ex. 1001, 41:10–54).

Patent Owner's argument that the word "accordingly" in claim 24 requires Petitioner to show "Severinsky's controller selects between the engine on and engine off thresholds in ***real time***" (Sur-Reply, 6–7) is not persuasive because there is no requirement in claim 24 that the engine on and off thresholds be varied in real time. In fact, the plain language of claim

24 suggests that the setpoint is not varied in real time because it requires "monitor[ing] patterns of vehicle operation *over time*."

For all of the foregoing reasons, Petitioner establishes that Severinsky discloses varying the setpoint as required by claim 24, at least, during the hysteresis mode.

*iii. Patent Owner's Second Contention*

Patent Owner's second contention is that "Nii adjusts the power output of a generator, which is not a 'setpoint,' *i.e.*, 'a predefined ***torque*** value that may or may not be reset.'" PO Resp. 27 (citing Ex. 1022, 2:14–18; Ex. 2016 ¶¶ 127, 145–152). According to Patent Owner, "the generator power output for charging the battery in a series hybrid vehicle has nothing to do with varying the claimed 'setpoint,' which is a parameter used by the controller for determining when to employ the engine or electric motor." *Id.* at 27-28 (citing Ex. 2016 ¶¶ 152–154).

Petitioner, in turn, contends it relies on Nii for "teach[ing] the same monitoring of repeated driving operations over time as the '347 Patent" and "Each identifies a daily commute as an example of a 'regular travel pattern' or 'repetitive driving pattern.'" Pet. Reply 2 (citing Ex. 1001, 40:56–41:9; Ex. 1022, 2:21–24, 5:59–64), 4 (citing Pet. 44–48). Patent Owner does not dispute that Nii discloses monitoring travel patterns such as daily commutes. *See generally* PO Resp.; Sur-reply.

Patent Owner's contention regarding the teachings of Nii is not persuasive because Petitioner does not rely on Nii for varying the setpoint. *See* Pet. 45. The '347 patent describes an example of a repeated driving operation as "the operator drives the same route from a congested suburban development to a workplace about the same time each morning." Ex. 1001, 40:60–62. Nii discloses monitoring a driver's repeated driving operations

over time and references a daily commute to work similar to the '347 patent. Ex. 1022, 2:1–5, 2:21–29, 2:62–67, 5:59–64; *see also* Ex. 1089, 140:15–148:7 (Dr. Shahbakhti testifying that Nii monitors a driver's repeated driving operations over time).

*iv. Patent Owner's Motivation to Combine Contentions*

Patent Owner interposes a number of contentions broadly directed to Petitioner's reasons for combining Severinsky and Nii which Patent Owner characterizes as based on a "flawed obviousness analysis and conclusory expert testimony." PO Resp. 28–41.

Patent Owner contends that because "Nii focuses on setting a constant generator output for charging the battery in a series hybrid by determining an average output power of a generator over a specified travel pattern," Nii does not vary a setpoint for determining when to use the engine or electric motor. *Id.* at 31 (citing Ex. 1022, Abstract, 2:1–18, 6:9–13, 7:12–19; Ex. 2016 ¶ 152). According to Patent Owner, "Nii is focused on determining an ***average*** output value because the engine and generator output remains ***unchanged*** no matter the fluctuation in the vehicle's instantaneous torque demand due to the fact that the engine and generator are ***decoupled*** from the wheels in a series hybrid vehicle" and "Nii's engine is ***always on***, [and] uses its 'pattern information' to set a value that remains the same no matter the change in the vehicle's instantaneous torque demand." *Id.* (citing Ex. 2016 ¶ 152). Based on this, Patent Owner contends that a skilled artisan would not apply Nii's pattern information to Severinsky because the challenged claim "compares the instantaneous torque required to propel the vehicle to the claimed 'setpoint,' and Nii fails to disclose anything remotely related to using its 'vehicle patterns' (which consist of time-averaged values) to more accurately adjust the setpoint in

relation to the ***instantaneous*** torque required to propel the vehicle." *Id.* at 31 (citing Ex. 2016 ¶ 153).

Petitioner, in turn, contends it "rel[ies] on Nii for 'monitoring a driver's repeated driving operations over time' and that a [skilled artisan] would [use] such pattern information to vary the 'setpoint' in Severinsky's control strategy." Pet. Reply 4 (citing Pet. 44–48, Dec. 32–33; Ex. 1008 ¶¶ 610–614; Ex. 1088 ¶¶ 34–37). Petitioner further contends Patent Owner's assertion that "Nii's engine output 'remains unchanged no matter the fluctuation in the vehicle's instantaneous torque demand'" is incorrect. *Id.* at 6 (citing PO Resp. 31). According to Petitioner, Nii discloses "the engine load (generator output) is dependent on the instantaneous load requirements, which influence power consumption" and "turning the engine off when the battery reaches a high state of charge level and that the engine control can be varied based on other techniques." *Id.* (citing Ex. 1022, 1:44–53; Ex. 1008 ¶¶ 45–50). Petitioner further contends that a skilled artisan would have understood "that repeated, high instantaneous torque demand over time would necessarily yield a high average torque demand, *as demonstrated by PO's own cited exhibits*" and "understood that average power requirements can directly correlate with driving patterns and be 'useful' for modifying the setpoint." *Id.* (citing Ex. 1008 ¶¶ 55–62; Ex. 2020, Fig. 7.10).

Patent Owner next contends that Petitioner's proposed incorporation of Nii's pattern information to increase overall efficiency "by immediately turning off the engine in recognition of a pattern of vehicle operation requiring low average power" is allegedly "false" and "makes no sense." PO Resp. 34–35 (citing Pet. 47; Ex. 2016 ¶¶ 155–156). According to Patent Owner, low average power "does not provide any information about the

***instantaneous*** torque requirement because averages do not provide any information regarding any one (instantaneous) value." *Id.* at 35.

Petitioner responds that "Nii's recognizing a pattern of vehicle travel and using the average power requirement could be used to adjust Severinsky's threshold for turning off the engine during hysteresis sooner or at a slightly higher percentage of MTO and corresponding speed (e.g., 25-28 mph), thus increasing vehicle fuel economy." Pet. Reply at 7 (citing Ex. 1088 ¶ 53).

Patent Owner next contends Petitioner's contention that a skilled artisan "would have recognized more broadly that incorporating the pattern information from Nii to vary the engine's setpoint would be beneficial because it would more closely align those values with the vehicle's actual torque requirements over time . . . is based on conclusory expert testimony, not evidence." PO Resp. 38 (citing Ex. 2016 ¶¶ 164–169). According to Patent Owner, Dr. Davis "does not explain what 'pattern information from Nii' a [skilled artisan] would use to improve Severinsky or how such 'pattern information' would more closely align Severinsky's setpoint with the 'vehicle's actual torque requirements." *Id.*

Patent Owner next contends Petitioner's contention that a skilled artisan would have had a reasonable expectation of success in connection with the proposed combination of Severinsky and Nii lacks evidentiary support. PO Resp. 40 (citing Pet. 48). According to Patent Owner, Petitioner "does not describe this 'pattern information' except for mentioning the 'average power requirements,'" and "fails to explain how Severinsky would use Nii's 'pattern information' to fine tune its control system." *Id.* (citing Ex. 2016 ¶¶ 172–174). Patent Owner further contends that Petitioner's "oversimplified analysis ignores the important distinctions

between serial and parallel hybrid architectures and amounts to arguing that Severinsky and Nii 'are in the same technological field,' which cannot support an obviousness finding." *Id.* at 41 (citing *Samsung Elecs. Co. v. Elm 3DS Innovations, LLC*, 925 F.3d 1373 (Fed. Cir. 2019)).

Petitioner, in turn, contends "series and parallel hybrid architectures are concerned with enhancing hybrid vehicle efficiency based on alterations to the control scheme," and "share primary considerations, such as controlling battery state of charge or determining when to employ the engine." Pet. Reply 4–5 (citing Ex. 1008 ¶ 614; Ex. 1089, 66:24–67:17, 68:7–69:15, 130:11–131:21, 138:24–140:21; Ex. 1088 ¶¶ 38–44). Petitioner further contends that the similarities between series and parallel hybrid architecture are demonstrated by portions of Ehsani 2005. *Id.* at 5 (citing Ex. 1088 ¶¶ 38–44; Ex. 2020).

For the following reasons, after considering all of Patent Owner's contentions, we determine that Petitioner establishes by a preponderance of the evidence that claim 24 is unpatentable over the combined teachings of Severinsky and Nii.

We start with the Supreme Court's instruction that "if a technique has been used to improve one device and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR*, 550 U.S. at 417. In this case, we must determine whether one of ordinary skill in the art would recognize that Nii's teaching of monitoring a driver's repeated driving patterns over time in a series hybrid vehicle would improve the operation of Severinsky's parallel hybrid vehicle in the same way. In order for us to resolve this question in Petitioner's favor, Petitioner must provide "some articulated reasoning with some

rational underpinning to support the legal conclusion of obviousness." *Id.* at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). However, bodily incorporation, *i.e.*, "an actual physical substitution of" the data resulting from Nii's pattern monitoring into Severinsky's control scheme, is not required. *See In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012) ("It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements."); *In re Nievelt*, 482 F.2d 965, 968 (CCPA 1973) ("Combining the teachings of references does not involve an ability to combine their specific structures.").

Many of Patent Owner's contentions fail at the outset because they are not sufficiently tethered to the language of claim 24 and/or are premised on the assumption that *data* resulting from Nii's monitoring of a driver's repeated driving operations over time, *i.e.*, the average power consumed by Nii's series hybrid during the daily commute for example, must be used by one of ordinary skill in the art to vary Severinsky's setpoint.

Claim 24, as construed, broadly requires "monitoring a driver's repeated driving operations over time" and does not specify any particular data resulting from the monitoring that must be used to vary the setpoint. As discussed above, we find that Nii discloses monitoring a driver's repeated driving operations over time. Patent Owner's argument that the *vehicle data*, *i.e.*, average power, resulting from Nii's monitoring a driver's repeated driving operations over time would not be used by a skilled artisan to vary Severinsky's setpoint does not change the fact that Nii discloses "monitoring a driver's repeated driving operations over time" which is all claim 24 requires.

Patent Owner argues extensively that Nii monitors a driver's repeated driving operations to obtain average power values for setting a generator output which, according to Patent Owner, has nothing to do with using vehicle operation patterns "to more accurately adjust the setpoint in relation to the ***instantaneous*** torque required to propel the vehicle." PO Resp. 31 (citing Ex. 2016 ¶ 153), 35, 38 (arguing that "Dr. Davis does not explain what 'pattern information from Nii' a [skilled artisan] would use to improve Severinsky or how such 'pattern information' would more closely align Severinsky's setpoint with the 'vehicle's actual torque requirements."); 40. We are not persuaded by these contentions because they are premised on a bodily incorporation of the *vehicle data* resulting from Nii's monitoring of a driver's driving operations over time directly into Severinsky's control scheme. Further, the '347 patent states that "[i]t is within the skill of the art to program a microprocessor to record and analyze such daily patterns and to adapt the control strategy accordingly" to "prevent repetitive engine starts." Ex. 1001, 40:67–41:5.

To the extent Patent Owner's contentions are premised on the alleged failure by Petitioner to show how a skilled artisan would have used average power data in the context of Severinsky's control scheme, Dr. Davis testifies "both series and parallel hybrid vehicles are concerned with average power requirements." Ex. 1088 ¶ 58). Dr. Davis directs us to Severinsky's disclosure of using average power for turning the engine on or off. Ex. 1088 ¶ 58 (citing Ex. 1013, 5:46–51, 8:10–19, 8:52–67; 17:34–42). In particular, Severinsky discusses "the average power required in typical city driving is less than 5 hp . . . the average power consumed in suburban driving is 10 hp." Ex. 1013, 8:14–17. Severinsky specifically provides that "engine 40 is cycled on and off in this speed range [25-35 mph] when the average power

demand is small" (i*d.* at 17:38–39) as opposed to "the engine running constantly after the vehicle reaches a speed of 30–35 mph." *Id.* at 17:38–39, 18:36–38. We, thus, find Severinsky discloses a relationship between low average power and cycling the engine on and off during suburban driving. Therefore, Patent Owner's argument that average power values are unrelated to Severinsky's setpoint for turning the engine on/off is contrary to this disclosure in Severinsky.

Based on the foregoing, we find that the reasons articulated by the Petitioner for combining the teachings of Severinsky and Nii discussed above are reasonable and supported by the cited disclosure of Severinsky and Nii and the testimony of Dr. Davis.

For all the foregoing reasons, Petitioner establishes by a preponderance of the evidence that claim 24 is unpatentable over Severinsky and Nii.

*E. Claim 2-Alleged Obviousness over Severinsky, Ehsani, & Nii*

Claim 2 depends from claim 1 and, similar to claim 24, recites "wherein said controller monitors patterns of vehicle operation over time and varies said setpoint SP accordingly."[11] Ex. 1001, 58:38–40. The Board previously determined that claim 1 was unpatentable over Severinsky and Ehsani and over Bumby. Ex. 1003, 22–23; Ex. 1004, 28.

[11] Similar to the challenge to claim 24, Petitioner provides a claim chart detailing the Board's prior findings that independent claim 1 is unpatentable over Severinsky and Ehsani. Pet. 37–39. Patent Owner does not dispute Petitioner's contentions concerning claim 1. PO Resp. 41–47.

For this ground, Petitioner relies on the same contentions concerning Nii as for the claim 24 challenge based on Severinsky and Nii. Pet. 48. Patent Owner relies on the same contentions as for claim 24. PO Resp. 17. For the same reasons discussed above in connection with the Severinsky and Nii ground for claim 24, Petitioner establishes by a preponderance of the evidence that claim 2 is unpatentable over Severinsky, Ehsani, and Nii.

### *F. Claim 33-Alleged Obviousness over Severinsky and Ma*

Claim 33 depends from claim 28, which in turn depends from claim 23. Ex. 1001, 61:11, 51. Claim 33 requires, *inter alia*, "a turbocharger being operatively and controllably coupled to said internal combustion engine" and "a sustained high-power turbocharged mode." *Id.* at 61:51–53.

#### *1. Overview of Ma – Exhibit 1021*

Ma discloses an internal combustion engine that includes a turbocharger or supercharger and an electric motor connected to a vehicle drive train. Ex. 1021, code (54), Fig. 1. Ma further discloses that the torque output of the engine can be augmented through use of a turbocharger. *Id.* at 5. Further, both regenerative braking system 18 and electric motor 20 are connected in parallel with the engine "to enable the torque driving the vehicle to be assisted when the output power of the engine 10 is low." *Id.*

#### *2. Analysis*

Petitioner provides an analysis of the limitations of claim 28 and contends that each of claim 28's limitations are disclosed in Severinsky. Pet. 26–28. Claim 28 recites, *inter* alia, "a low-load mode," "a highway cruising mode," and "an acceleration mode." Ex. 1001, 61:15–22. Patent Owner does not dispute Petitioner's mapping of Severinsky to the elements of claim 28. PO Resp. 48–62.

Petitioner contends "Ma discloses a vehicle having an 'internal combustion engine (10) calibrated to operate in a lean burn mode comprising means for supplementing the total output torque,' including 'a supercharger' (or turbocharger) and 'an auxiliary motor.'" Pet. 29 (citing Ex. 1008 ¶ 474; Ex. 1021, Abstract, 3:10–20). Petitioner further contends "Ma makes clear that the use of the turbocharger and an electric motor are not mutually exclusive approaches at supplementing engine power, but rather that 'more than one source of supplementary torque may be used.'" *Id.* at 30 (citing Ex. 1008 ¶ 476; Ex. 1021, 3:26–29). Petitioner further contends Ma's turbocharger "is controllably coupled to the ICE for being operated thereby" and "is only employed when needed." *Id.* (citing Ex. 1008 ¶ 477; Ex. 1021, 5:11–18, 5:26–30).

Petitioner also contends that it would have been obvious to supplement Severinsky's hybrid vehicle configuration with Ma's turbocharger because Severinsky teaches using an electric motor in its hybrid vehicle configuration when the required torque exceeds the capabilities of the engine and Ma teaches using a turbocharger to enhance the engine's output in circumstances requiring maximum performance. *Id.* at 31 (citing Ex. 1008 ¶¶ 479–480; Ex 1013, 14:15–26; Ex. 1021, 4:32–5:5). According to Petitioner, a skilled artisan "would have known of 'the conventional technique of assisting the engine by the traction motor' —as disclosed in Severinsky 'in a high speed acceleration and/or hill climbing mode'—'when torque in excess of the capabilities of engine 40 is required.'" *Id.* (citing Ex. 1013, 14:15–26). Petitioner contends Ma uses "almost identical language describing how the turbocharger can be used in 'times when the engine is being driven to maximum performance . . .' for providing torque in excess of MTO." *Id.* (citing Ex. 1008 ¶ 480; Ex. 1021,

4:32–5:5). Petitioner further contends that a skilled artisan "would have known that using a turbocharger would provide the additional benefits of allowing a smaller engine to be used in the vehicle and to provide better engine efficiency, resulting in improved fuel economy" and "would have been particularly motivated to achieve these efficiency benefits during extended periods of driving during which the instantaneous torque required to propel the vehicle exceeds the engine's MTO." *Id.* at 32 (citing Ex. 1008 ¶¶ 482–483).

Petitioner next contends a skilled artisan would have been motivated to include Ma's turbocharger in Severinsky's hybrid vehicle and "would have had no difficulty in doing so as turbochargers were well known in the art, as were the means by which they could be incorporated into hybrid vehicles as recognized by Ma and the '347 patent." *Id.* (citing Ex. 1001, 45:15–38; Ex. 1008 ¶¶ 483–484; Ex. 1021, 5:20–25). With respect to the recited "sustained high-power turbocharged Mode VI," Petitioner contends that Severinsky "discloses that a microprocessor ("*controller*") determines which mode to implement . . . [and] once a turbocharger were added . . . it would have been obvious to a [skilled artisan] to include the '*turbocharged mode IV*.'" *Id.* at 32–33 (citing Ex. 1008 ¶¶ 486–487; Ex. 1013, 6:23–26, 10:4–43, 12:64–13:21, 17:11–15).

Patent Owner first contends Severinsky's electric motor already provides the benefits touted by Petitioner in asserting that a skilled artisan "would have modified Severinsky with Ma's turbocharger to supplement Severinsky's engine with additional torque 'in times when the engine is being driven for maximum performance, *i.e.*, 'high acceleration and high speed' for providing torque in excess of MTO, 'to further enhance the

engine output.'" PO Resp. 49 (citing Pet. 31; Ex. 1021, 4:32–5:5; Ex. 1013, 14:15–26; Ex. 2016 ¶¶ 56–57).

Patent Owner next contends Severinsky discloses that its electric motor also allows "a relatively small engine." *Id.* (citing Pet. 32; Ex. 1013, 8:52–9:55; Ex. 2016 ¶¶ 58–63). Patent Owner next contends that Ma's Figure 1[12] disclosure of both a turbocharger and electric motor "provides no reason as to why a [skilled artisan] would use both sources of supplemental torque when just one is sufficient, especially in the context of Severinsky where the electric motor alone is adequate to supplement the engine." *Id.* at 52–53 (citing Ex. 2016 ¶¶ 73–74). According to Patent Owner, a skilled artisan would not modify Severinsky with Ma because "Severinsky is considered a 'full hybrid' where the electric motor is sufficiently powerful to propel the vehicle on its own" but "Ma . . . is directed to a 'power assist' hybrid where the electric motor is used only to supplement the engine." *Id.* at 53 (citing Ex. 2016 ¶ 74). Patent Owner further contends that "[a]t best Ma discloses that the turbocharger and electric motor ***could be*** alternatives to assist an underpowered engine" but "does not disclose why a [skilled artisan] would use ***both*** a turbocharger and an electric motor in the same system, especially when Ma uses both elements for the same purpose (*i.e.*, provide supplemental torque)." *Id.* at 54–55 (citing Ex. 1021, 7; Ex. 2016 ¶¶ 80–83).

Patent Owner next contends that Petitioner's "'second reason to combine and obviousness assertions regarding the 'sustained high-power

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[12] Patent Owner characterizes Ma's disclosure of both an electric motor and turbocharger in Figure 1 as a mere "suggest[ion] that a turbocharger and electric motor ***could*** be operated in a single system." PO Resp. 50 n.22.

turbocharged mode VI' limitation of claims 11 and 33 are based on hindsight not evidence." PO Resp. 55. Patent Owner provides a comparison between the Petition and the Specification of the '347 patent in support of the contention that the second reason to combine is based on improper hindsight. *Id.* at 56 (comparing Pet. 32 and Ex. 1001, 45:1–14). Patent Owner does not direct us to any evidence from the '347 patent in support of its improper hindsight assertion regarding the "sustained high-power turbocharged mode VI" limitation. *See id.* Patent Owner next contends that "the '347 patent's combination of the electric motor and turbocharger yielded unpredictable results — the elimination of turbo lag and preservation of the battery — teaching absent in the prior art." *Id.* at 57 (citing Ex. 1001, 45:1–14, 46:7–11; Ex. 2016 ¶ 83). Patent Owner further contends that "supplementing the engine with a turbocharger instead of an electric motor as Dr. Davis suggests would significantly reduce efficiency" because "[t]urbocharged engines at the time of the invention typically had a brake fuel conversion efficiency of 35-40% whereas electric motors commonly had efficiencies greater than 70%." *Id.* at 58 (citing Ex. 2016 ¶¶ 65–67; Ex. 2019, Fig. 15–38; Ex. 2021, Table 1).

Patent Owner next contends that "disadvantages of adding a turbocharger to a parallel hybrid significantly outweigh BMW's improper reasons to combine." PO Resp. 58. Patent Owner argues that a skilled artisan would understand that "adding a turbocharger to Severinsky's naturally-aspirated engine would cause detrimental effects to the engine such as 'engine knock' . . . which can cause major engine damage and unacceptable engine noise." *Id.* at 59 (citing Ex. 2016 ¶¶ 91–92). Patent Owner further contends that "reducing the compression ratio of Severinsky's engine (to address knock) is unacceptable because a reduction in

compression ratio leads to a reduction in engine efficiency." *Id.* (citing Ex. 2016 ¶¶ 92–93). Patent Owner further contends that "turbocharging is particularly a bad idea in Severinsky because turbocharged gasoline engines are less efficient than naturally-aspirated engines, especially at the engine's 'sweet-spot' where Severinsky specifically endeavors to operate the engine." *Id.* (citing Ex. 1013, 17:68–18:2, 20:63–21:4; Ex. 2016 ¶¶ 94–95). Patent Owner further contends that "[a] turbocharger is also ill-suited in Severinsky because turbochargers only improve efficiency at low loads where Severinsky does not utilize the engine at all." *Id.* at 60 (citing Ex. 2016 ¶¶ 96–99; Ex. 2019, 874). Patent Owner also contends that a turbocharger will result in added weight which reduces efficiency, "packaging problems, and unnecessary complications involving engine control and calibration." *Id.* at 60–61 (citing Ex. 2016 ¶¶ 84–90, 100–101).

Petitioner, in turn, responds that "[i]t would have been obvious to supplement the 'torque output of the engine" in . . . Severinsky's . . . hybrid by using a 'turbocharger,' *as expressly taught by Ma*, to arrive at the claimed limitations." Pet. Reply 16 (citing Pet. 31–33, 62–65; Ex. 1021, Fig. 1). Petitioner contends that "[e]ach reference concerns hybrid vehicle control in order to maximize the engine's fuel efficiency by using supplemental sources of torque." *Id.* (citing Pet. 29–33, 62–65; Ex. 1008 ¶¶ 473–486, 831–842). According to Petitioner, "[t]hese 'interrelated teachings' alone provide a sufficient motivation to combine." *Id.* (citing *ZUP, LLC v. Nash Mfg., Inc.,* 896 F. 3d 1365, 1371 (Fed. Cir. 2018); Dec. 38.).

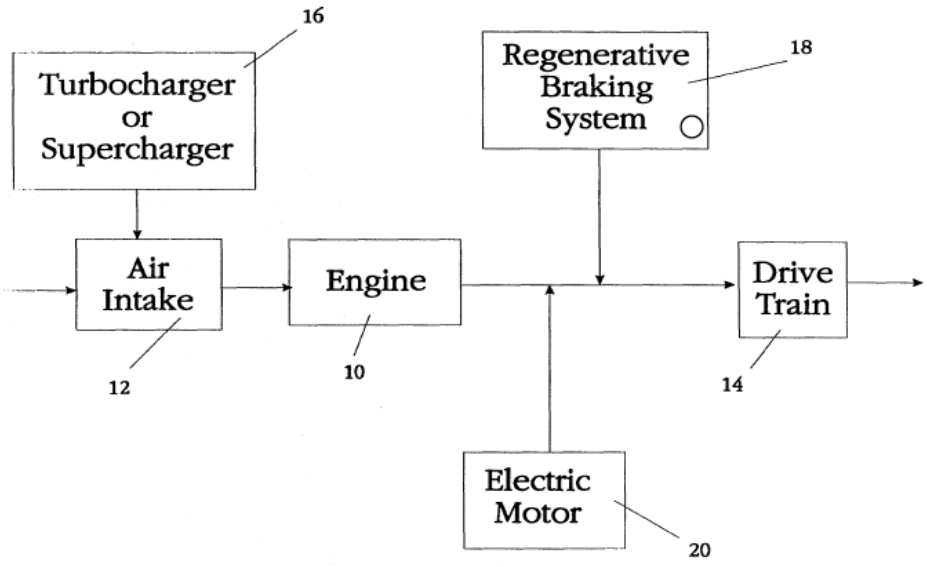
Petitioner takes issue with Patent Owner's assertion that "Ma only 'discloses that it is *possible* to combine a turbocharger and an electric motor.'" *Id.* (citing PO Resp. 52–55). Petitioner contends that "Ma expressly teaches an engine deployed in conjunction with multiple 'source[s]

of additional torque,' including a "Turbocharger' *and* an 'Electric Motor,' supplementing torque with '***any** one **or more*** of the[se] supplementary sources." *Id.* (citing Ex. 1021, Abstract, Fig. 1, 7:11–18, 7:27–36).

Petitioner next disputes Patent Owner's contention that the alleged benefits of adding Ma's turbocharger to Severinsky are redundant by reiterating the reasons stated in the Petition. Pet. Reply 17 (citing Pet. 32; Ex. 1008 ¶¶ 481–482). Petitioner contends that "Turbochargers were widely known to improve at least diesel engines' peak fuel efficiency, and to improve *overall* engine fuel efficiency to both diesel and gasoline engines by increasing the engine's efficient operating range." *Id.* at 18 (citing Ex. 1008 ¶¶ 147–148; Ex. 1088 ¶¶ 72–88; Ex. 2019, Figs. 15-38, 15-40). Based on this, Petitioner contends that a skilled artisan "would have [ ] been motivated to combine Ma's turbocharger with Severinsky's . . . vehicle to *further* 'reduce fuel consumption,' which is an express goal of Ma." *Id.* (citing Ex. 1021, 1:30–34; Ex. 1088 ¶ 88). Petitioner likewise contends that with respect to size considerations, a skilled artisan "would be motivated by space, weight, and battery charge considerations to use a turbocharged engine rather than using a larger electric motor to increase torque output, as PO appears to suggest doing." *Id.* at 19 (citing Ex. 1088 ¶¶ 89–93). Petitioner also contends that "[t]he addition of turbochargers [ ] was well understood, and a [skilled artisan] would know how to properly size and calibrate the engine for use with a turbocharger, as recognized by Ma and the '347 Patent itself." *Id.* at 20–21 (citing Ex. 1001, 45:15–38; Ex. 1088 ¶¶ 100–107, 143–154, 483; Ex. 1021, 5:20–25).

For the following reasons, after considering all of Patent Owner's contentions, we determine Petitioner establishes by a preponderance of the evidence that claim 33 is unpatentable over Severinsky and Ma.

Patent Owner attempts to circumvent the explicit disclosure in Ma's Figure 1 by arguing that "Ma merely suggests that a turbocharger and electric motor ***could*** be operated in a single system." PO Resp. 50 n.6; *see also id.* at 52 ("Ma's Figure 1 at best discloses that it is possible to combine a turbocharger and an electric motor in the same system."). To the contrary, Ma does not merely suggest, but in fact, explicitly discloses using an electric motor operating in parallel with a turbocharged engine in the embodiment shown in Ma's Figure 1. Pet. Reply 16–17. Ma's Figure 1 is reproduced below:




Ma describes the system shown in this Figure as:

> In the drawing, an engine 10 has an air intake system 12 and a drive train 14. The output torque of the engine can be augmented by means of a supercharger or turbocharger 16 connected to the intake system 12. A regenerative braking system 18 and an electric motor 20 are connected to the drive train 14 *in parallel with the engine to enable the torque driving the vehicle to be assisted when the output power of the engine 10 is low.*

Ex. 1021, 7:11–18, Fig. 1 (emphasis added). Patent Owner's contentions disregard this explicit disclosure of how both a turbocharger and electric motor can be used in a parallel hybrid drive train. Dr. Shahbakhti, in fact, testifies Ma discloses "the engine, turbocharger, originally with the braking system and electric motor. And then it shows that they are linked by arrow to the drivetrain." Ex. 1089, 148:23–149:8. The fact that Ma explicitly discloses how to use both an electric motor and a turbocharger in a parallel hybrid in Figure 1 significantly undercuts Patent Owner's contentions.

Petitioner must provide an "explanation as to how or why the references would be combined to produce the claimed invention." *Trivascular, Inc. v. Samuels*, 812 F. 3d 1056, 1066 (Fed. Cir. 2016). As discussed above, we find Ma discloses how to modify Severinsky to incorporate a turbocharger. With respect to why a skilled artisan would combine Severinsky and Ma, the Federal Circuit explains that

> motivation to combine may be found explicitly or implicitly in market forces; design incentives; the 'interrelated teachings of multiple patents'; 'any need or problem known in the field of endeavor at the time of invention and addressed by the patent'; and the background knowledge, creativity, and common sense of the person of ordinary skill.

*Zup, LLC v. Nash Manufacturing, Inc.*, 896 F.3d 1365, 1371 (Fed. Cir. 2018).

In this case, Ma and Severinsky both relate to hybrid vehicles with parallel drive trains. Severinsky discloses a system with a non-turbocharged internal combustion engine and an electric motor. Ex. 1013, Fig. 3. Ma discloses a system with an electric motor and a turbocharged engine. Ex. 1021, Fig. 1. Ma discloses a goal of "reducing fuel consumption" but recognizes the problem that an efficient engine "lacks power." Ex. 1021,

1:30–2:2. Both Ma and Severinsky disclose providing additional torque to supplement the torque provided by the engine alone. Ex. 1013, 3:16–20; Ex. 1008 ¶¶ 474, 475; Ex. 1021, Abstract, 3:10–20. Ma explicitly discloses that "more than one source of supplementary torque may be used." Ex. 1008 ¶ 476; Ex. 1021, 3:26–29. A skilled artisan, thus, would have been motivated to consider Ma's explicit teachings and add Ma's turbocharger to Severinsky because Ma and Severinsky disclose interrelated teachings addressing the problem of supplementing the torque of an internal combustion engine in a hybrid drive train. Consequently, we determine that Petitioner shows how and why a skilled artisan would have combined Severinsky and Ma to produce the claimed invention.

Patent Owner's contention that a skilled artisan would not have added Ma's turbocharger to Severinsky because Severinsky is a full hybrid in contrast to Ma which, according to Patent Owner is a power assist hybrid, is not persuasive for several reasons. First, claim 33 makes no distinction between full hybrids and power assist hybrids. Second, this contention is based on Dr. Shahbakhti's testimony (Ex. 2016 ¶¶ 74–75) who testifies Ma is "hard to understand and does not make sense." Ex. 1089, 149:20–24. Dr. Shahbakhti points to use of the word "auxiliary" preceding the word "motor" in Ma's Abstract with no other citation to Ma in support of his opinion that Ma is a power assist hybrid. *See* Ex. 2016 ¶ 74. Given the paucity of support in Ma for this testimony and his admission that Ma is hard to understand and does not make sense, we find Dr. Shahbakhti's testimony that Ma discloses a power assist hybrid to be entitled to little weight. Third, even if Dr. Shahbakhti's testimony were credible, we agree with Petitioner that this contention is improperly premised on a bodily incorporation of

Ma's alleged power assist hybrid into Severinsky's full hybrid. *See* Pet. Reply 20 (citing Ex. 1088 ¶ 94).

Patent Owner's contention that the benefits of adding a turbocharger to Severinsky are redundant is not persuasive for the following reasons. Patent Owner focuses on a statement in our Decision on Institution that Petitioner's first reason for the combination, *i.e.*, "to supplement Severinsky's hybrid vehicle to provide torque in excess of MTO to further enhance the output of the engine," was supported by disclosure in Ma and was sufficient for institution purposes. PO Resp. 50 (citing Dec., 38). Patent Owner cites two Federal Circuit cases for the proposition that there is no reason to combine "Severinsky and Ma because Severinsky alone already achieves the purported benefit associated with the addition of Ma's turbocharger." *Id.* at 51 (citing *South-Tek Systems, LLC v. Engineered Corrosion Solutions, LLC*, 748 Fed. Appx. 1003 (Fed. Cir. 2018); *Kinetic Concepts, Inc. v. Smith and Nephew, Inc.*, 688 F.3d 1342 (Fed. Cir. 2012)).

Although we preliminarily found that Petitioner's first reason for the combination was sufficiently established for institution purposes under the reasonable likelihood standard, Petitioner stated other reasons why a skilled artisan would have combined Severinsky and Ma including "allowing a smaller engine to be used," "provide better engine efficiency resulting in improved fuel economy," and "preserve battery charge, by taking some of the torque generation burden away from the motor." Pet. 31–32. Patent Owner does not contend that these other alleged benefits are redundant. *See* PO Resp. 50–51.

Regardless of whether adding a turbocharger to Severinsky would provide the same benefit as Severinsky's electric motor, taking some of the torque generation burden away from the electric motor to preserve battery

charge is a specific non-redundant improvement to Severinsky's system. This reason is supported by the testimony of Dr. Davis. Ex. 1008 ¶ 482; Ex. 1088 ¶ 92 (citing Ex. 1013, 6:19–21; Ex. 1045, 3). Dr. Shahbakhti contends that Dr. Davis's testimony is based on hindsight because allegedly Ma "does not teach using the electric motor and turbocharger together to supplement the engine ***during different time periods*** to maintain the state of charge of the battery." Ex. 2016 ¶ 72. We find that Dr. Shahbakhti's criticism of Dr. Davis's testimony is entitled to little weight because of his opinion that Ma does not disclose using both the turbocharger and electric motor (Ex. 2016 ¶ 76), which, as we discussed above, is not correct. Therefore, we find Dr. Davis's testimony to be more credible and entitled to substantial weight, which distinguishes this case from *Kinetic Concepts*. In *Kinetic Concepts*, the Federal Circuit determined the patent challenger "never offered evidence articulating why a person having ordinary skill in the art would combine the primary references to obtain the disclosed inventions." *Kinetic Concepts*, 688 F. 3d at 1368–1369.

We are not persuaded by Patent Owner's contention that Petitioner's second reason for the combination is based on hindsight. PO Resp. 55–56. Patent Owner argues that the Petition parrots language from the '347 patent by highlighting in red certain language from the Petition and the '347 patent. *Id.* at 56. Dr. Davis, however, relies on Ma in support of this reason for the combination which, similar to the '347 patent, discloses that the turbocharger "may be used during high performance driving to further enhance the engine output." Ex. 1021, 5:4–5; *see also* Ex. 1008 ¶ 480 (citing Ex. 1021, 4:32–5:5). Consequently, Patent Owner's improper hindsight argument is not persuasive.

We are also not persuaded by Patent Owner's improper hindsight argument with respect to the "sustained high-power turbocharged mode VI" limitation. PO Resp. 56. In connection with claim 28, Petitioner directs us to specific disclosure from Severinsky and testimony from Dr. Davis in support of its contentions that Severinsky discloses the operational modes recited in claim 28. Pet. 27–28. As discussed above, Petitioner points to specific evidence from Severinsky supported by Dr. Davis's testimony why it would have been obvious to a skilled artisan to implement the turbocharged mode IV in addition to the modes recited in claim 28. *See* Ex. 1008 ¶¶ 485–487; Ex. 1013, 6:23–26, 10:4–43, 12:64–13:21, 17:11–15. Based on this evidence from Severinsky, we are not persuaded that the Petition relies on improper hindsight in connection with the turbocharged mode IV.

Consequently, for all the foregoing reasons, we determine that Petitioner establishes by a preponderance of the evidence that claim 33 is unpatentable over Severinsky and Ma.

*G. Claim 11-Alleged Obviousness over Severinsky, Ehsani, & Ma*

Claim 11 depends from claim 7 which in turn depends from claim 1.[13] Ex. 1001, 58:58–59:30. Claim 11, similar to claim 33, requires, *inter alia*, "a turbocharger operatively and controllably coupled to" the internal combustion engine. *Id.* at 59:30–39.

For this ground, Petitioner relies on the same contentions concerning Ma as for the claim 33 ground based on Severinsky and Ma. Pet. 40. Patent

[13] The Board previously determined that claims 1 and 7 were unpatentable in IPR2014-00571. Ex. 1003.

Owner relies on the same contentions for this ground as for the claim 33 ground based on Severinsky and Ma. PO Resp. 48–62. For the same reasons discussed above in connection with the Severinsky and Ma ground for claim 33, Petitioner establishes by a preponderance of the evidence that claim 11 is unpatentable over Severinsky, Ehsani, and Ma.

### *H. Claim 38-Alleged Obviousness over Bumby and Ehsani*

Claim 38, which depends from claim 23, requires, *inter alia*, controlling the speeds of the output shaft of the engine and/or first motor and the output shaft of the second motor to be substantially equal when the clutch is engaged, so that a non-slipping clutch may be used. Ex. 1001, 62:29–37.

#### *1. Overview of Bumby I to V – Exhibits 1014–1018*

Bumby I–V are a series of technical journal publications published in the 1980's. The articles all relate to research performed by Dr. J.R. Bumby relating to hybrid vehicles. *See generally* Exs. 1014–1018.

#### *2. Overview of Ehsani – Exhibit 1019*

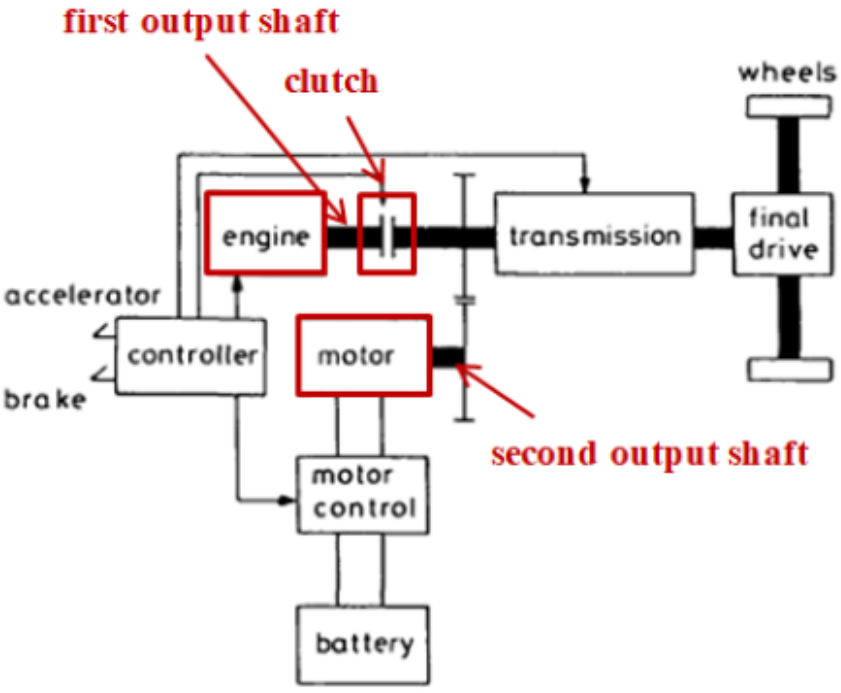
Ehsani discloses a "series hybrid electric-combustion system." Ex. 1019, code (57). Ehsani's drive system includes clutch 40 that "may be a slipping or catching clutch." *Id.* at 7:59–61.

#### *3. Analysis*

Claim 23 was previously determined to be unpatentable over Bumby. Ex. 1004. Petitioner directs us to evidence underlying the Board's prior determination that Bumby discloses every limitation of claim 23. Pet. 49–

55. Patent Owner does not dispute any of Patent Owner's contentions for claim 23. *See generally* PO Resp.

Petitioner contends "Bumby discloses that 'the electric traction motor is connected permanently to the drive shaft, while the ic engine is connected through a 'one-way clutch' or 'freewheel.'" Pet. 66 (citing Ex. 1017, 3; Ex. 1015, 3). Petitioner further contends Bumby's engine is started in its efficient operating regions and "accelerated up to the speed of the drivetrain, and then connected to the road wheels via the clutch." *Id.* at 66–67 (citing Ex. 1017, 3; Ex. 1018, 3, 5). Petitioner provides an annotated version of Figure 2 of Ex. 1015, reproduced below, to illustrate its contention that Bumby's clutch connects the first output shaft of the engine with a second output shaft of, or driven by, the electric motor connected to the wheels:




Petitioner's reproduction of Figure 2 of Exhibit 1015 illustrates a parallel hybrid electric vehicle drive train with annotations added in red by Petitioner

to identify the engine, motor, clutch, first output shaft, and second output shaft. *Id.* at 67 (citing Ex. 1015, 1, Fig. 2).

Petitioner further contends a skilled artisan would have recognized that the speeds of the motor and engine need to be synchronized before engaging the clutch "to prevent a harsh engagement and possible damage to the drivetrain, particularly the one-way clutch" and, consequently, would have understood that speeds of the first output shaft and the second output shaft are substantially equal as required by claim 38. *Id.* at 68 (citing Ex. 1008 ¶¶ 868–870). Petitioner further contends a skilled artisan would have selected a non-slipping clutch because such a clutch "was known to lead to better efficiency than a slipping clutch, which produces heat and wastes power during engagement." *Id.* (citing Ex. 1008 ¶ 871). Petitioner further contends Bumby suggests a clutch that is "continually slipped or modulated . . . is not particularly attractive" and asserts a skilled artisan would have understood "Bumby's 'one-way clutch' is a particular type of non-slipping clutch." *Id.* at 68–69 (citing Ex. 1008 ¶¶ 872–873; Ex. 1015, 4). Petitioner alternately relies on Ehsani for disclosure of a non-slipping clutch. *Id.* at 70 (citing Ex. 1008 ¶ 874).

Patent Owner contends "Bumby V indicates 'synchronization is deemed complete when the engine speed is within 45 rev/min of the drive-train speed'" which Patent Owner contends "is not 'substantially equal.'" PO Resp. 71 (citing Ex. 1018, 132; Ex. 2016 ¶¶ 189–192). According to Patent Owner, "[a]t the time of the invention, engine speed controllers controlled engine speed to within +/- 15 rpms, which is a factor of three more accurate." *Id.* (citing Ex. 2016 ¶¶ 189–192; Ex. 2016, Fig. 9; Ex. 2027, Fig. 14). Patent Owner further contends because Bumby V uses a "free-wheel unit" rather than a conventional clutch system, control of shaft

speeds to be "substantially equal" is unnecessary. *Id.* at 71–72 (citing Ex. 2016 ¶¶ 183–185, 192). Patent Owner also contends a "45 rpm disparity would result in 'extensive slipping' that the '347 patent counsels against" and "would not be sufficiently precise such that the shafts could be connected by a non-slipping clutch." *Id.* at 74 (citing Ex. 1001, 26:46; Ex. 2016 ¶¶ 193–197).

Petitioner, in turn, contends the question of whether the "substantially equal" limitation is met depends on context. Pet. Reply 27. Petitioner contends Bumby discloses "the engine speed is . . . 'synchroni[zed] with the moving, and possibly accelerating, drive train,' so that it does not 'overshoot prevailing drive-train speed, thus avoiding a shock torque in the drive shaft as the one-way clutch is engaged." *Id.* (citing Ex. 1018, 5). Petitioner further contends Bumby discloses "synchronizing the speeds within 45 rpm would have been deemed complete, indicating that such synchronization would have been viewed [ ] as sufficient." *Id.* (citing Ex. 1018, 6; Ex. 1089, 112:1–21). Petitioner further contends that "the 45 rpm buffer is in the context of engine speeds reaching as high as 1600 or 2000 rpm" which according to Petitioner "is consistent with industry publications that describe a 'precise' clutch management system as being able to control clutch slip to 'between 50 and 100 rpm.'" *Id.* at 27–28 (citing Ex. 1088 ¶¶ 139–140; Ex. 1097, 138). Petitioner also contends Patent Owner's contention that 15 rpm should be treated as substantially equally is based on references directed to "idle-speed control systems, not clutch management systems" and controlling the engine at "approximately 700 rpm." *Id.* at 28 (citing Ex. 1088 ¶ 181; Ex. 1089, 92:10–93:6, 96:2–19; Ex. 2026, 1, Ex. 2027, 1). Petitioner further contends Patent Owner's arguments about Bumby's "free-wheel" do not address the claim language which requires "that a non-

slipping clutch 'may be' used" and that Bumby's "free-wheel" "is a 'one-way clutch' —i.e., a non-slipping clutch." *Id.* (citing Ex. 1018, 5; Ex. 1088 ¶ 142).

Patent Owner responds Bumby's "free-wheel unit" "is not controllably engaged/disengaged like a two-way clutch" and Bumby's "synchronization is only possible with 'free-wheel unit.'" Sur-reply 26. Patent Owner contends that Exhibit 1097 relied on by Petitioner for the contention that 50 rpm to 100 rpm is substantially equal "discloses 'control[ing] slip to reduce noise and still comply with clutch wear standards' in slipping (friction) clutches where shaft speeds do ***not*** have to be substantially equal.'" *Id.* (citing Ex. 1097, 2, 7–17, 25; Ex. 2029, 24:20–25:5).

The issue in dispute is whether Bumby's disclosure of a 45 rpm difference in shaft rotational speeds satisfies the limitation in claim 38 of controlling the shaft speeds to be "substantially equal whereby said shafts may be connected by a non-slipping clutch." Both parties agree that claim 38 does not require a non-slipping clutch. Tr. 56:20–21 (Patent Owner arguing "the non-slipping part of the clutch is not mandatory, but it provides context in the claim."), 22:9 (Petitioner arguing "the language about a non-slipping clutch is permissive . . . it shouldn't be necessary to address a permissive limitation in analyzing the claims."). Patent Owner's arguments based on Bumby's alleged engagement of shafts using a freewheel are, thus, not persuasive because Petitioner is not required to show Bumby uses a non-

slipping clutch only that Bumby controls the shaft speeds to be substantially equal.[14]

The parties do not direct us to any specific portions of the '347 patent or its prosecution history to support their respective positions concerning the meaning of "substantially equal." We discern little guidance from our own review of the '347 patent. The '347 patent states the microprocessor "controls operation of engine 40, motor 21, and motor 25 as necessary to ensure that the shafts are rotating at substantially the same speed before engaging clutch 51" and consequently, "clutch 51 need not necessarily be an ordinary automotive friction clutch . . . as conventionally provided to allow extensive relative slipping before the shafts are fully engaged." Ex. 1001, 26:28–37. From the claim language and this portion of the Specification, we discern that the claim term "substantially equal" suggests that a non-slipping clutch may be used and that a conventional friction clutch is not necessary but is not precluded either. However, this provides minimal assistance to us in evaluating whether Bumby's 45 rpm difference in shaft rotational speeds meets the "substantially equal" limitation.

Patent Owner relies on Exhibits 2026 and 2027 and Dr. Shahbakhti's testimony to support its position that +/- 15 rpm should be our guidepost for "substantially equal" in the context of claim 38. Dr. Shahbakhti testifies that a skilled artisan "understood [ ] at the time of the invention that embedded automotive controllers were capable of controlling engine speed to within +/- 15 rpm as shown by the graph below depicting conventional engine idle

[14] Patent Owner concedes that "100 percent accuracy is not realistic." Tr. 56:26.

speed control." Ex. 2016 ¶ 190 (citing Ex. 2026, Fig. 9; Ex. 2027, Fig. 14). Figure 9 of Exhibit 2026 indicates the +/- 15 rpm speed variation is the deviation over a time period of the engine idle speed from a constant speed of approximately 750 rpm. Ex. 2026, Fig. 9. Dr. Shahbakhti characterizes this speed control of +/-15 rpm as "more precise tha[t] Bumby V's disclosure of 45 rpm by a factor of 3." Ex. 2016 ¶ 191.

Petitioner directs us to Bumby's disclosure that when "the engine is required, it must be started and synchronized with the moving and possibly accelerating drive train" and that "[s]ynchronization is deemed complete when the engine speed is within 45 rev/min of the drive-train speed." Ex. 1018, 5–6. In that regard, Bumby discloses that the engine speed starts from approximately zero and accelerates over a time period of about one second up to the speed of the electric motor which, at the time of synchronization with the engine, is running at approximately 1400 rpm. *Id.* at Fig. 5. Petitioner counters Dr. Shahbakhti's testimony with that of Dr. Davis who testifies that "contemporary industry publications describe a 'precise' clutch management system as being able to control slip to 'between 50 and 100 rpm'—i.e., only half as accurately as the amount taught by Bumby." Ex. 1088 ¶ 140 (citing Ex. 1097, 138).

For the following reasons, we credit Dr. Davis's explanation of why Bumby's 45 rpm speed difference between shaft speeds satisfies the "substantially equal" limitation of claim 38. First, as Patent Owner concedes, the non-slipping clutch language in claim 38 provides context for the claim and the context is "something coming together." Tr. 56:23. Here, the context is two moving shafts being engaged by a clutch. *See* Ex. 1001, 26:25–50 (discussing engaging a clutch in the context of two shafts "rotating at substantially the same speed"). Second, Dr. Davis's testimony is tethered

to the context of this claim, *i.e.*, two shafts coming together by means of a clutch. Dr. Shahbakhti relies on an engine idle speed controller without sufficient explanation as to how such a controller is tethered to the context of two shafts coming together. Third, Dr. Shahbakhti does not address whether the +/- 15 rpm variation in engine speed would be the same or different for constant engine speeds above 750 rpm or whether this variation would even apply in the context of the quickly accelerating engine shaft in Bumby. Further, Dr. Shahbakhti fails to address how the +/- 15 rpm variation applies to *two moving shafts* in Bumby which, in theory, could result in a speed difference of 30 rpm (one shaft rotating at +15 rpm and the other shaft rotating at -15 rpm) between the two shafts when the clutch is engaged. Dr. Shahbakhti's failure to address these points leaves his assertion that the references on which he relies are three times more precise than Bumby not sufficiently supported. For all of the foregoing reasons, we find Dr. Davis's testimony to outweigh that of Dr. Shahbakhti on the issue of whether Bumby's 45 rpm speed difference between the two shafts satisfies the "substantially equal" limitation of claim 38.

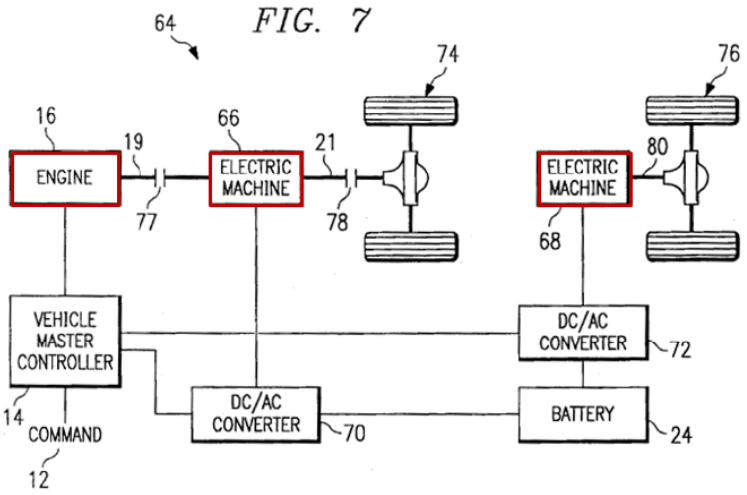
Based on the disclosure in Bumby and the testimony of Dr. Davis, Petitioner establishes by a preponderance of the evidence that claim 38 is unpatentable over Bumby. Petitioner relies on Ehsani for "another example of another non-slipping clutch." Pet. 69. There is no dispute that claim 38 does not require a non-slipping clutch. For reasons previously stated, Petitioner has shown that Bumby alone teaches or suggests all features of claim 38, and, thus, that claim 38 is unpatentable by a preponderance of the evidence over the combination of Bumby and Ehsani.

*I. Claim 17-Alleged Obviousness over Bumby and Ehsani*

Claim 17, depends from claim 1, and recites "the engine and first electric motor are controllably coupled to a first set of road wheels of said vehicle and said second electric motor is coupled to a second set of road wheels of said vehicle." Ex. 1001, 59:64–67.

a. *Alleged Obviousness over Bumby and Ehsani*

Petitioner contends that the '347 patent specifically refers to Ehsani's teaching of "a vehicle configuration with a drive arrangement using one electric motor and engine to drive a first set of road wheels, and an independent second drive arrangement using a second electric motor to drive a second set, as shown in Ehsani's" Figure 7. Pet. 41 (citing Ex. 1001, 10:14–30). Petitioner's annotated version of Ehsani's Figure 7 is reproduced below:




Petitioner's reproduction of Ehsani's Figure 7 illustrates a hybrid electric vehicle drive train with annotations added in red by Petitioner to identify the engine and first electric motor that are connected to a first set of drive wheels and a second electric motor that is connected to a second set of drive

wheels. *Id.* at 41 (citing Ex. 1019, Fig. 2). Petitioner contends that Ehsani's "four wheel drive architecture was adopted in" claim 17. *Id.*

Petitioner contends "Bumby teaches a two-motor architecture with one motor for starting the engine and a second motor for driving the vehicles' wheels." Pet. 71 (citing Ex. 1008 ¶¶ 852–853); *id.* at 57 (claim elements 1b, 1c); *id*. at 52 (claim element 23d). Petitioner provides the following annotated version of Bumby II's Figure 2 (Pet. 49):

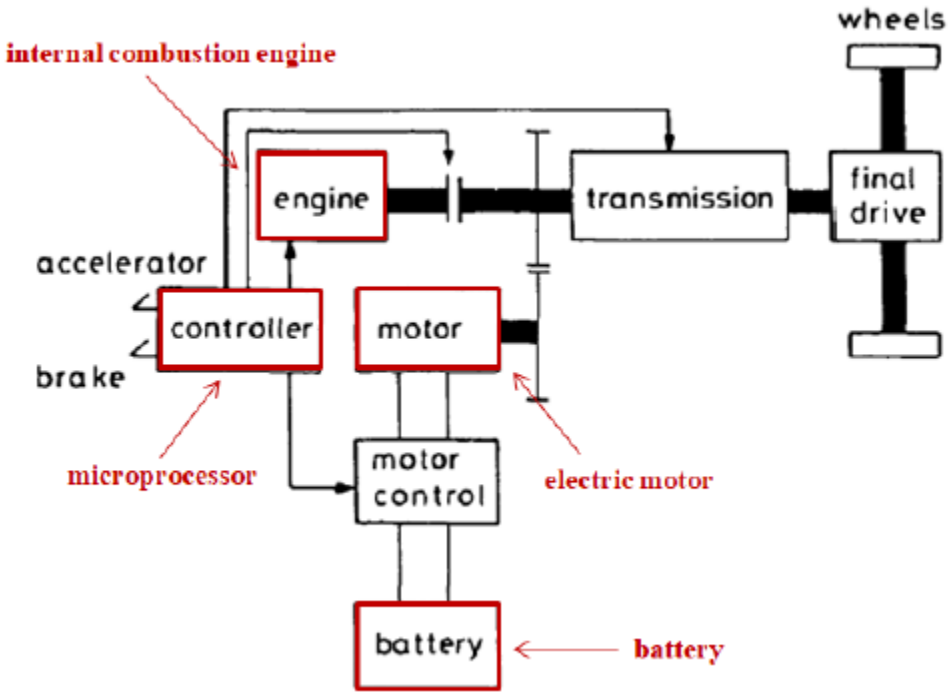



Figure 2 illustrates a "parallel hybrid electric vehicle drive train." Ex. 1015, 1. Petitioner adds annotations in red to identify the engine, a microprocessor controller, electric motor, and battery. Pet. 49.

Petitioner further contends that, based on Ehsani, a skilled artisan "would have known that the 'starter motor' of Bumby could be replaced with an electric motor that could start both the engine and drive the wheels (or act as a generator)." Pet. 71. Petitioner contends a skilled artisan would have been motivated to make the changes to Bumby "to allow the hybrid

vehicle of Bumby to have the additional advantages . . . of being a four-wheel drive vehicle." *Id.* (citing Ex. 1008 ¶ 854). Petitioner specifically points to the advantages of a four wheel drive vehicle "in certain driving and weather conditions" and "better acceleration and traction as torque is being provided to both sets of road wheels" and "for commercial reasons and increased use cases, such as in a sport utility vehicle." *Id.* at 42 (citing Ex. 1008 ¶ 599).

Patent Owner contends Petitioner "asserts that a [skilled artisan] would convert Bumby's conventional starter motor into a motor/generator [ ] to make Bumby four-wheel drive" but "fails to explain how or why a [skilled artisan] would move Bumby's motor for propelling the vehicle to the rear wheels." PO Resp. 75. Patent Owner further contends that Petitioner's motivation to combine is conclusory and insufficient to establish obviousness. *Id.* (citing *In re Nuvasive, Inc.*, 842 F.3d 1376, 1382 (Fed. Cir. 2016)).

Petitioner replies it did not "propose moving one of those motors to the rear wheels 'without explanation'" but cited "various advantages of turning Bumby into a four-wheel drive vehicle, and the practical reasons for moving the 'second motor,' rather than the 'first,' to the rear wheels." Pet. Reply 26 (citing PO Resp. 75; Pet. 70–72).

We start with the undisputed fact that the '347 patent itself cites Ehsani as disclosing a drive train where the engine and one electric motor drive one set of wheels and a second electric motor independently drives a second set of wheels. Ex. 1001, 10:14–30. Ehsani's disclosure is incorporated into claim 17.

The Board previously determined that claim 1 of the '347 patent, which requires a first electric motor and a second electric motor, was

obvious over Bumby. Ex. 1004, 30. In connection with the prior determination, the Board found that Bumby "teach[es] a 'conventional starter motor' that is activated by 'a microprocessor-controlled starting system.'" *Id.* at 25 (citations omitted); *see also* Ex. Ex. 1008 ¶¶ 630–634.

Patent Owner's contentions are based on misconstruing Petitioner's proposed modification to Bumby. PO Resp. 75. Petitioner proposes to modify Bumby by replacing Bumby's starter motor "with an electric motor that could start both the engine and drive the wheels" and "controllably couple this motor . . . to the same set of wheels as the engine . . . because the '*first motor*' is used to start the engine." Pet. 71. Petitioner proposes that Bumby's second motor would be coupled to the second set of wheels. *Id.* In fact, Bumby discloses that its electric motor, shown in Figure 2 above, is "capable of driving the road wheels." Ex. 1015, 1. Petitioner supports its position with the testimony of Dr. Davis. Ex. 1008 ¶¶ 852–857; Ex. 1088 ¶¶ 120–121.[15] Petitioner's proposed drive train configuration is disclosed in Ehsani. *See* Ex. 1019, 3:30–33, 8:62–9:7, Fig. 7; *see also* Ex. 1008 ¶ 856 ("Ehsani specifically teaches such an arrangement."). We, thus, find Dr. Davis's testimony to be credible and supported by the disclosure of Bumby and Ehsani. Contrary to Patent Owner's argument, the foregoing evidence cited by Petitioner shows *how* one of ordinary skill in the art would have modified Bumby based on the specific disclosure of Ehsani. *Trivascular, Inc. v. Samuels*, 812 F.3d 1056, 1066 (Fed. Cir. 2016 (citations omitted). Further, Petitioner relies on Dr. Davis's undisputed testimony of the

[15] Dr. Shahbakhti does not dispute Dr. Davis's testimony regarding claim 17. *See generally* Ex. 2016.

advantages of four-wheel drive over two-wheel drive vehicles. Ex. 1008 ¶ 599. Patent Owner's attorney argument as to the alleged defects in Dr. Davis's testimony for the reasons *why* a skilled artisan would combine the teachings of Bumby and Ehsani does not undercut Dr. Davis's testimony or Petitioner's position.

For all the foregoing reasons, we determine that Petitioner establishes by a preponderance of the evidence that claim 17 is unpatentable over Bumby and Ehsani.

## III. PETITIONER'S ALTERNATE CHALLENGES

Because we have decided that all of the challenged claims are unpatentable on the challenges previously discussed, we do not reach Petitioner's alternate challenges to claim 24 over Severinsky and Graf, claim 2 over Severinsky, Ehsani, and Graf, claim 17 over Severinsky and Ehsani, claim 38 over Severinsky and Ehsani, claims 2 and 24 over Bumby and Graf, and claims 11 and 33 over Bumby and Ma. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner "is entitled to a final written decision addressing all of the claims it has challenged."); *see also* 35 U.S.C. § 318(a).

## IV. PETITIONER'S MOTION TO EXCLUDE

Petitioner filed a Motion to Exclude Evidence ("Mot.") (Paper 39), Patent Owner filed an Opposition ("Opp.") (Paper 41), and Petitioner filed a Reply ("Excl. Reply") (Paper 42).

Petitioner moves to exclude Dr. Shahbakhti's Declaration, Exhibit 2016, as inadmissible under Federal Rules of Evidence 402 and 702. Mot. 1. Petitioner also moves to exclude Exhibits 2018, 2020, 2022–2025 and 2028 that are relied on by Dr. Shahbakhti under Rule 402 because the exhibits

"post-date the '347 Patent's earliest priority date by anywhere from a few years to *two decades*, [and] are not relevant to any ground upon which this trial was instituted." *Id.*

*a. Dr. Shahbakhti's Declaration – Ex. 2016*

Petitioner contends that Dr. Shahbakhti "is unable to testify accurately from the perspective of a [skilled artisan]" because, *inter alia*, he had no industry experience in September 1988 and did not obtain his bachelor's degree until 2000. Mot. 3–4. Petitioner supports this contention by arguing that Dr. Shahbakhti took an inordinate amount of time answering questions posed to him during his deposition and allegedly failed to provide responsive answers to questions. *Id.* at 4–6 (citing various portions of Ex. 1109). Petitioner further argues that Dr. Shahbakhti's reliance on post-filing date Exhibits 2018, 2020, 2022–2025, and 2028 support its contention that Dr. Shahbakhti's testimony from the perspective of skilled artisan in September 1998 should be excluded. *Id.* at 6–7. Petitioner contends that because "[Dr.] Shahbakhti has no perspective of a skilled artisan as of 1998" he should be prohibited from testifying on obviousness. *Id.* at 8 (citing *Sundance, Inc. v. DeMonte Fabricating Ltd.*, 550 F.3d 1356, 1363 (Fed. Cir. 2008)).

Patent Owner counters that Dr. Shahbakhti qualifies as an expert because, *inter alia*, he earned a Bachelor's Degree in Mechanical Engineering in 2000, a Master's Degree in 2003, and a Doctorate Degree in Mechanical Engineering in 2009. Opp. 4 (citing Ex. 2016 ¶ 9). Patent Owner further contends that "Dr. Shahbakhti has well over a decade of experience 'work[ing] as a researcher in the automotive industry' where he was 'involved in research and development work on power train management systems for gasoline and natural gas vehicles.'" *Id.* at 5 (citing

Ex. 2016 ¶¶ 10–12). Patent Owner also directs us to Dr. Shahbakhti's experience teaching graduate level courses in internal combustion engines and hybrid electric vehicles and various publications he has authored. *Id.* at 6–7. Patent Owner next contends that "both the Federal Circuit and the PTAB have recognized 'a person may not need to be a person of ordinary skill in the art in order to testify as an expert under Rule 702, but rather must be 'qualified in the pertinent art.'" *Id.* at 8 (citing Consol. TPG, 3 (2018); *Mytec Prods., Inc. v. Harris Research, Inc.* 439 Fed. App'x, 882, 886–87 (Fed. Cir. 2011)). Patent Owner also contends that "[i]t is neither surprising nor unusual that an expert would take their time to answer such questions" and notes that "BMW was unable to identify any precedent that supports' "excluding expert testimony because the witness took too much time answering questions." *Id.* at 9.

*i. Analysis*

Our Consolidated Trial Practice Guide provides that "[a]n expert witness must be qualified as an expert by knowledge, skill, experience, training, or education to testify in the form of an opinion." Consol. Trial Practice Guide, 34 (Nov. 2019) (citing Fed. R. Evid. 702). Further, the Trial Practice Guide also provides that "[a] person may not need to be a person of ordinary skill in the art in order to testify as an expert under Rule 702, but rather must be 'qualified in the pertinent art.'" *Id.* (citing *Sundance, Inc. v. DeMonte Fabricating Ltd.,* 550 F.3d 1356, 1363–64 (Fed. Cir. 2008)).

In this case, Dr. Shahbakhti is qualified in the pertinent art. He earned a Ph.D in Mechanical Engineering and engaged in "research activities in the past 20 years . . . centered on design, modeling and control of automotive propulsion systems, including conventional, hybrid electric, and electric vehicles." Ex. 2016 ¶ 9. He also "spent two years as a post-doctoral scholar

at the Mechanical Engineering Department at the University of California, Berkeley." *Id.* ¶ 8. He is currently "an Associate Professor of Mechanical Engineering at the University of Alberta and an Adjunct Professor of Mechanical Engineering at Michigan Technological University." *Id.* ¶ 7. Dr. Shahbakhti also engaged extensively in various relevant research and development activities including building "a hybrid electric powertrain test platform including a 100-kW AC electric motor and a 201-kW GM Ecotec engine . . . for testing various aspects of powertrain performance including real-time torque control during transient and steady state operations." *Id.* ¶¶ 10–11.

Petitioner doesn't specifically quarrel with Dr. Shahbakhti's qualifications in the pertinent art *per se* but rather focuses on whether he is sufficiently versed in the pertinent art as of September 1999 to offer testimony from the perspective of one of ordinary skill in the art. Petitioner notes that Dr. Shahbakhti did not earn his bachelor's degree until 2000 and, thus, was not a person of ordinary skill in the art in September 1999. Mot. 3–4. This fact is irrelevant to our determination because an expert does not have to be one of ordinary skill in the art during the relevant time frame to be qualified as an expert. *T. Rowe Price Inv. Servs., Inc. v. Secure Axcess, LLC*, CBM2015-00027, Paper 31, 22 (PTAB June 13, 2016) ("the Federal Circuit has not placed temporal restrictions, such as requiring an expert be qualified in the pertinent art at the time of the invention."). Petitioner next points to several exhibits relied on by Dr. Shahbakhti that are dated after September 1999 (Mot. 6) but does not point to any specific portions of Dr. Shahbakhti's testimony to support its contention that Dr. Shahbakhti's testimony is either unreliable or inadmissible because of these documents. *See id.* Finally, Petitioner's reliance on the Federal Circuit decision in

*Sundance* is unavailing. In *Sundance*, a patent attorney who was not qualified as an expert in the relevant art testified on "invalidity, including the factual predicates underlying obviousness as well as his conclusion that claim 1 . . . would have been obvious." 550 F. 3d at 1361. The Federal Circuit held that the district court abused its discretion by denying a motion in limine to exclude the testimony because the witness in that case, unlike Dr. Shahbakhti, was "not qualified in the pertinent art to testify as an expert on obviousness." *Id.* at 1364. The fact that Dr. Shahbakhti may have taken a long time to answer particular questions or may have given unresponsive answers goes to the weight, if any, to be assigned to his testimony not its admissibility.

For all the foregoing reasons, we deny Petitioner's motion to exclude Dr. Shahbakhti's testimony.

*b. Exhibits 2018, 2020, 2022–2025 and 2028*

We do not rely on any of these exhibits in our resolution of Petitioner's challenges. This portion of the Motion is, thus, dismissed as moot. Consol. Trial Practice Guide at 79–80.

## V. 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 |
|---|---|---|---|---|
| 24 | 103(a) | Severinsky, Graf | | |
| 33 | 103(a) | Severinsky, Ma | 33 | |
| 38 | 103(a) | Severinsky, Ehsani | | |
| 2 | 103(a) | Severinsky, Ehsani, Graf | | |
| 11 | 103(a) | Severinksy, Ehsani, Ma | 11 | |
| 17 | 103(a) | Severinsky, Ehsani | | |
| 24 | 103(a) | Severinsky, Nii | 24 | |
| 2 | 103(a) | Severinsky, Ehsani, Nii | 2 | |
| 2, 24 | 103(a) | Bumby, Graf | | |
| 11, 33 | 103(a) | Bumby, Ma | | |
| 17, 38 | 103(a) | Bumby, Ehsani | 17, 38 | |
| **Overall Outcome** | | | 2, 11, 17, 24, 33, 38 | |

## VI. ORDER[16]

In consideration of the foregoing, it is hereby:

[16] 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).

ORDERED that, based on a preponderance of the evidence that claims 2, 11, 17, 24, 33, and 38 of the '347 patent are unpatentable as set forth in the summary table above; 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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