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Paper 32
Entered: September 26, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FORD MOTOR COMPANY,
Petitioner,

v.

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

Case IPR2015-00800
Patent 7,237,634 B2

Before JAMESON LEE, SALLY C. MEDLEY, and
CARL M. DEFRANCO, *Administrative Patent Judges*.

LEE, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. Background

Ford Motor Company ("Petitioner") filed a Petition (Paper 1, "Pet.") for *inter partes* review of U.S. Patent No. 7,237,634 B2 (Ex. 1901, "the '634 patent"). The Petition challenges the patentability of claims 80, 91, 92, 95, 96, 99, 100, 102, 106, 114, 125, 126, 129, 132, 133, 135, 161, 172, 215, 226, 230, 233, and 234 of the '634 patent. In an Initial Decision, we instituted *inter partes* review of six claims, i.e., claims 161, 172, 215, 226, 230, and 234, but declined to institute review of the other sixteen challenged claims. Paper 12 ("Dec. Inst.").

Paice LLC and The Abell Foundation, Inc. ("Patent Owner") filed a Patent Owner Response (Paper 15, "PO Response"), and Petitioner filed a Reply (Paper 19, "Reply").[1] Oral hearing was held on June 29, 2016. A transcript of the oral hearing is included in the record. Paper 31 ("Tr."). Neither party filed a motion to exclude evidence.

For reasons discussed below, we (1) dismiss the *inter partes* review with respect to claims 161 and 215, and (2) determine that Petitioner has shown by a preponderance of the evidence that each of claims 172, 226, 230, and 234 is unpatentable.

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[1] In addition, Patent Owner filed a Motion for Observation on Cross-Examination (Paper 23) and Petitioner filed a Response to Motion for Observation on Cross-Examination (Paper 26), both of which have been considered.

B. Related Matters

Petitioner and Patent Owner collectively identify the following civil actions in which the '634 patent has been asserted: (1) *Paice LLC et al. v. Ford Motor Company*, Case No. 1-14-cv-00492 (D. Md.); (2) *Paice LLC et al. v. Hyundai Motor America, et al.*, Case No. 1:2012-cv-00499 (D. Md.). Papers 1, 5. The '634 patent also is the patent involved in the following *inter partes* review proceedings: IPR2014-00904, IPR2014-01416, IPR2015-00606, IPR2015-00722, IPR2015-00758, IPR2015-00784, IPR2015-00785, IPR2015-00787, IPR2015-00790, IPR2015-00791, IPR2015-00799, and IPR2015-00801.

C. The '634 Patent

The '634 patent describes a hybrid vehicle with an internal combustion engine, at least one electric motor, and a battery bank, all controlled by a microprocessor that directs torque transfer between the engine, the motor, and the drive wheels of the vehicle. Ex. 1901, 17:17–56, Fig. 4. The microprocessor compares the vehicle's torque requirements and the engine's torque output against a predefined setpoint and uses the results of the comparison to control the vehicle's mode of operation, e.g., straight-electric, engine-only, or hybrid. *Id.* at 40:16–49. The microprocessor utilizes a hybrid control strategy that operates the engine only in a range of high fuel efficiency, which occurs when the instantaneous torque required to drive the vehicle, or road load (RL), reaches a setpoint (SP) of approximately 30% of the engine's maximum torque output (MTO). *Id.* at 20:61–67; *see also id*. at 13:64–65 ("the engine is never operated at less than

30% of MTO, and is thus never operated inefficiently"). Operating the engine in a range above the setpoint but substantially less than the maximum torque output maximizes fuel efficiency and reduces pollutant emissions of the vehicle. *Id.* at 15:55–58.

Independent claims 161 and 215 are illustrative, and are reproduced below.

> 161. A method for controlling a hybrid vehicle, comprising:
>
> determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
>
> wherein the hybrid vehicle is operated in a plurality of operating modes corresponding to values for the RL and a setpoint (SP);
>
> operating at least one first electric motor to propel the hybrid vehicle when the RL required to do so is less than the SP;
>
> wherein said operating the at least one first electric motor to drive the hybrid vehicle composes a low-load operation mode I;
>
> operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO;
>
> wherein said operating the internal combustion engine of the hybrid vehicle to propel the hybrid vehicle composes a high-way cruising operation mode IV;

operating both the at least one first electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO;

wherein said operating both the at least one first electric motor and the engine to propel the hybrid vehicle composes an acceleration operation mode V;

receiving operator input specifying a change in required torque to be applied to wheels of the hybrid vehicle; and

if the received operator input specifies a rapid increase in the required torque, changing operation from operating mode I directly to operating mode V.

Id. at 73:42–74:9.

215. A method for controlling a hybrid vehicle, comprising:

determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;

operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);

operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO; and

operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and

> regeneratively charging a battery of the hybrid vehicle when instantaneous torque output of the engine > the RL, when the RL is negative, and/or when braking is initiated by an operator of the hybrid vehicle.

Id. at 79:10–31.

Claim 172 depends from claim 161. Each of claims 226, 230, and 234 depends from claim 215.

D. Evidence Relied Upon

Prior Art References		Date	Exhibit
Bumby I	J.R. Bumby et al., *Computer Modelling of the Automotive Energy Requirements for Internal Combustion Engine and Battery Electric-Powered Vehicles*, 132:5 IEE PROC. 265–279 (1985)	Sept. 6, 1994	Ex. 1905
Bumby II	J.R. Bumby and I. Forster, *Optimisation and Control of a Hybrid Electric Car*, 134:6 IEE PROC. 373–387 (1987)	Nov. 1987	Ex. 1906
Bumby III	J.R. Bumby and I. Forster, *A Hybrid Internal Combustion Engine/Battery Electric Passenger Car for Petroleum Displacement*, 202:D1 PROC. INST. MECH. ENGRS. 51–64 (1988)	Jan. 1988	Ex. 1907

Prior Art References		Date	Exhibit
Bumby IV	J.R. Bumby and P.W. Masding, *A Test-Bed Facility for Hybrid IC-Engine/Battery-Electric Road Vehicle Drive Trains*, 10:2 TRANS. INST. MEASUREMENT & CONTROL 87–97 (1988)	Apr. 1988	Ex. 1908
Bumby V	J.R. Bumby and P.W. Masding, *Integrated Microprocessor Control of a Hybrid I.C. Engine/Battery-Electric Automotive Power Train*, 12:3 TRANS. INST. MEASUREMENT & CONTROL 128–146 (1990)	Jan. 1990	Ex. 1909
Masding	Philip Wilson Masding, *Some Drive Train Control Problems in Hybrid I.C. Engine/Battery Electric Vehicles*, Durham theses, Durham University (1988), available at Durham E-Theses Online: http://etheses.dur.ac.uk/6408/	Nov. 2, 1989[2]	Ex. 1910

[2] Petitioner attached to Masding a declaration from the Chief Operating Officer of Durham University, Paulina Lubacz, who testified that Masding would have been indexed and searchable by the general public since around November 2, 1989, a date stamped on the cover of Masding. Ex. 1910, 1–2.

Petitioner also relies on the declarations of Gregory W. Davis, Ph.D. Ex. 1903 ("first Declaration of Dr. Davis"), Ex. 1951 ("reply Declaration").

E. The Asserted Grounds of Unpatentability

The only ground of unpatentability on the basis of which we instituted review of any claim in this proceeding is identified below:[3]

References	Basis	Claims Challenged
Bumby I, II, III, IV, V, and Masding	§ 103(a)	161, 172, 215, 226, 230, and 234

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are interpreted according to their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142–46 (2016). Under the rule of broadest reasonable interpretation, claim terms generally also are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Only terms

[3] Although Petitioner adds the general knowledge of one with ordinary skill in the art to the express statement of each alleged ground of unpatentability (Pet. 22, 51), that is not necessary. Obviousness is determined from the perspective of one with ordinary skill in the art. We leave out the express inclusion of the general knowledge of one with ordinary skill.

which are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc*., 200 F.3d 795, 803 (Fed. Cir. 1999).

If an inventor acts as his or her own lexicographer, the definition must be set forth in the specification with reasonable clarity, deliberateness, and precision. *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1249 (Fed. Cir. 1998). It is improper to add an extraneous limitation into a claim, i.e., one that is added wholly apart from any need for the addition to accord meaning to a claim term. *See, e.g.*, *Hoganas AB v. Dresser Indus., Inc*., 9 F.3d 948, 950 (Fed. Cir. 1993); *E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co*., 849 F.2d 1430, 1433 (Fed. Cir. 1988).

"road load (RL)"

The term "road load" or "RL" is recited in each of independent claims 161 and 215. The Specification defines "road load" as "the vehicle's instantaneous torque demands, i.e., that amount of torque required to propel the vehicle at a desired speed," and further notes that it "can be positive or negative, i.e., when decelerating or descending a hill, in which case the negative road load . . . is usually employed to charge the battery bank." Ex. 1901, 12:44–61. Accordingly, we construe "road load" and "RL" as "the amount of instantaneous torque required to propel the vehicle, be it positive or negative." This construction is the same as that proposed by Petitioner. Pet. 9. Patent Owner does not propose a different construction.

"setpoint (SP)"

The term "setpoint" or "SP" is recited in each of independent claims 161 and 215. Petitioner proposes that "setpoint" or "SP" be construed, in the context of these claims, as "predetermined torque value." Pet. 11. In that regard, Petitioner correctly notes that the claims compare the setpoint either to an engine torque value or a torque based "road load" value. *Id.* at 10. Each of claims 161 and 215 recites a condition "when the RL required to do so is less than a setpoint (SP)." Ex. 1901, 73:51–52, 79:16–17. Each of claims 161 and 215 further defines a range established by the setpoint at one end, and the maximum torque output of the engine at the other end, by the language "when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine." *Id.* at 73:57–59, 79:19–21.

Nothing in the Specification precludes a setpoint from being reset, after it has been set. A setpoint for however short a period of time still is a setpoint. Accordingly, we construe "setpoint" and "SP" as "predetermined torque value that may or may not be reset."

Patent Owner argues that the claims and the Specification of the '634 patent "make clear that a 'setpoint' is not simply a numerical value divorced from the context of the rest of the control system," and that "'setpoint' serves the crucial function of marking the transition from one claimed mode to another, and in particular, the transition from propelling the vehicle with the motor to propelling the vehicle with the engine." PO Resp. 7. The argument is misplaced. Although such use of a setpoint is described by other language in the Specification, it is not an intrinsic property of a

setpoint and is not a necessary and required use of all setpoints. In that regard, we further note the following passage in the Specification of the '634 patent, which supports not reading in a mode switching requirement into the term "setpoint":

> the values of the sensed parameters in response to which the operating mode is selected may vary . . ., so that *the operating mode is not repetitively switched simply because one of the sensed parameters fluctuates around a defined setpoint*.

Ex. 1901, 19:67–20:6 (emphasis added).

It is improper to add an extraneous limitation into a claim, i.e., one that is added wholly apart from any need for the addition to accord meaning to a claim term. *See, e.g.*, *Hoganas AB*, 9 F.3d at 950; *E.I. du Pont de Nemours*, 849 F.2d at 1433. It is important not to import into a claim limitations that are not a part of the claim. *SuperGuide Corp. v. DirecTV Enterprises, Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004). For example, a particular embodiment appearing in the written description may not be read into a claim when the claim language is broader than the embodiment. *Id.*; *see also In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993). That is no different even if the patent specification describes only a single embodiment. *Liebel-Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 906 (Fed. Cir. 2004).

Patent Owner brings to our attention that the U.S. District Court for the Eastern District of Texas and the U.S. District Court for the District of Maryland both have construed "setpoint" to mean "a definite, but potentially variable value at which a transition between operating modes may occur." PO Resp. 6 n.1. We note that that construction also does not require that an

operating mode be changed at a setpoint, as Patent Owner urges. Instead, the construction of the district courts sets forth that a transition between operating modes "may occur" at a setpoint, which is consistent with our construction here.

Patent Owner additionally argues that "setpoint" should not be limited to a torque value, because the Specification makes clear that it also can be the state of charge of a battery. PO. Resp. 10. Patent Owner cites to the following passage in the Specification:

> [T]he microprocessor tests sensed and calculated values for system variables, such as the vehicle's instantaneous torque requirement, i.e., the "road load" RL, the engine's instantaneous torque output ITO, both being expressed as a percentage of the engine's maximum torque output MTO, *and the state of charge of the battery bank BSC*, expressed as a percentage of its full charge, *against setpoints*, and uses the results of the comparisons to control the mode of vehicle operation.

Ex. 1901, 40:16–26 (emphasis added). The argument also is misplaced. As we noted above, each independent claim 161 and 215 requires a comparison of the setpoint either to an engine torque value or a torque based "road load" value. Thus, in the context of these claims, and claims dependent therefrom, a setpoint must be a torque value, and not some state of charge of a battery.

For reasons discussed above, we construe "setpoint" and "SP" as "predetermined torque value that may or may not be reset."

"mode I,"
"operating mode I"
"low-load operation mode I,"
"high-way cruising operation mode IV,"
"operating mode V"
"acceleration operation mode V"

Independent claim 161 recites limitations referring to "low-load operation mode I," "operating mode I," "high-way cruising operation mode IV," "acceleration operation mode V," and "operating mode V." Claim 234 depends from claim 215 and recites a limitation referring to "mode I." The Specification of the '634 patent sets forth a definition for these modes.

With regard to "mode I," the Specification states:

> As noted, during low-speed operation, such as in city traffic, the vehicle is operated as a simple electric car, where *all torque* is provided to road wheels 34 by traction motor 25 operating on electrical energy supplied from battery bank 22. This is referred to as "mode I" operation (see FIG. 6), and is illustrated in FIG. 8(a).

Ex. 1901, 35:63–36:1 (emphasis added).

Petitioner proposes a construction for "mode I" that disregards the "all torque" requirement quoted above. Pet. 11–12. Patent Owner does not propose a construction. We construe "mode I," in accordance with the above-quoted description in the Specification, as "a mode of operation of the vehicle, in which all torque provided to the wheels are supplied by an electric motor." We construe "low-load operation mode I" and "operating mode I," the same as we do "mode I," because it is evident that "low-load

operation mode I" and "operating mode I" are each just another name for "mode I."

With regard to "high-way cruising operation mode IV," the Specification states:

> When the operator releases pressure on the accelerator pedal, indicating that a desired cruising speed has been reached, traction motor 25 is accordingly depowered. The highway cruising mode is referred to as "mode IV" operation, and the flow of energy and torque are as illustrated in FIG. 8(c).

Ex. 1901, 36:31–36. Figure 8(c) shows that all power to the wheels are supplied from the internal combustion engine. Additionally, the Specification states: "[d]uring highway cruising, region IV, where the road load is between about 30% and 100% of the engine's maximum torque output, the engine alone is used to propel the vehicle." *Id*. at 37:42–44. Petitioner's proposed construction disregards the exclusivity of the power source. Pet. 11–12. Patent Owner does not offer a construction. We construe "high-way cruising mode IV" as "a mode of operation in which all torque provided to the wheels are supplied by the internal combustion engine."

With regard to "acceleration operation mode V," the Specification states:

> If extra torque is needed during highway cruising, e.g., for acceleration or hill-climbing, either or both of motors 21 and 25 can be powered. This "mode V" operation is illustrated in FIG. 8(d); energy flows from tank 38 to engine 40, and from battery bank 22 to traction motor 25, and possibly also to starting motor 21; torque flows from either or both motors and engine to wheels 34.

Ex. 1901, 36:37–43. The Specification further states:

> If the operator then calls for additional power, e.g., for acceleration or passing, region V is entered; that is, when the microprocessor detects that the road load exceeds 100% of the engine's maximum torque output, it controls inverter/charger 27 so that energy flows from battery bank 22 to traction motor 25, providing torque propelling the vehicle in addition to that provided by engine 40. Starting motor 21 can similarly be controlled to provide propulsive torque.

Id. at 38:1–8. Patent Owner does not offer a construction. We construe "acceleration operation mode V" as "a mode of operation in which torque provided to the wheels is supplied by the internal combustion engine and at least one electric motor." Also, "operating mode V" means the same, because evidently it is merely an abbreviated name for "acceleration operation mode V."

That the Claims Require a Comparison of Road Load (RL) to Setpoint (SP) and to MTO

Patent Owner asserts that the challenged claims require a comparison of road load (RL) to setpoint (SP) and also to maximum torque output (MTO). PO Resp. 11–13. The assertion is based on the requirements in claims 161 of (1) operating at least one first electric motor to propel the hybrid vehicle "when the RL required to do so is less than the SP," (2) operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle "when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine," and (3) operating both the at least one first electric motor and the engine to propel the hybrid vehicle

"when the torque RL required to do so is more than the MTO," and essentially the same recitations in claim 215.

In the above discussion of the construction of setpoint, we already noted that claims 161 and 215 each require a comparison of road load to a setpoint because of the claim recitations "when the RL required to do so is less than the SP" and "when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine." For similar reason, claims 161 and 215 each require a comparison of road load to a maximum torque output (MTO) because of the recitation "when the torque RL required to do so is more than the MTO." Petitioner has not advanced any cogent reasoning why no such comparison is required by the claims. We determine that the claims require a comparison of road load (RL) to a setpoint (SP) and also to a maximum torque output (MTO). That, however, does not mean the claims exclude the comparison of other parameters.

B. Combining Teachings of Prior Art References

The Petition is atypical in that it refers to a collection of six prior art references, i.e., Bumby I, Bumby II, Bumby III, Bumby IV, Bumby V, and Masding, collectively as "the Durham Project." Pet. 12. Petitioner proceeds, in pages 22–55 of the Petition, to apply "the Durham Project" as though it were a single publication. However, those portions of the Petition only discuss the prior art references generally, in the absence of the context provided by any claim limitation. The Petition does include a section titled "Overview of the University of Durham Hybrid Project" in pages 12–19, and a section titled "Reasons to Combine" in pages 19–22. Patent Owner,

however, contends that Petitioner's approach is categorically improper. PO Resp. 13–14. According to Patent Owner, Petitioner "fails to identify the differences between the Bumby references and independent claims 161 and 215," contrary to the well-established analytical framework for determining obviousness, citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). PO Resp. 13–14. Patent Owner states: "Ford's failure to perform a proper obviousness analysis is made worse by the incorrect assumption of the existence of an aggregate 'Durham Project,' causing Ford to fail to explain which specific reference discloses each limitation and the difference between the specific reference and the claim elements." *Id.* at 15.

Patent Owner further asserts:

> However, the only reasons Ford presents to justify the combination of five different references (written by varying combinations of four different authors over the course of five years, in three different journals), is that the articles share a common author and cite to each other. *See* Pet. at 19 ("Each subsequent Bumby publication expressly discusses and cites the preceding Bumby publications."). The mere fact that a publication refers to other publications written by a similar group of authors, much less a common single author, provides no justification for combining the *technology* of the various references.

Id. at 33.

Patent Owner is correct in indicating that the mere fact that multiple prior art publications refer to each other does not mean everything disclosed in each is automatically combinable for use with everything else in the disclosure of the others. But the language quoted by Patent Owner above from page 19 of the Petition does not simply state that the references refer to

each other. Rather, Petitioner notes that "each subsequent Bumby publication **expressly discusses and cites the preceding Bumby publications**." Pet. 19. The Petition also indicates that the references "chronologically document[] the progression of a hybrid vehicle project from its inception as a software simulation tool, through the design of a control strategy for operating the hybrid vehicle, and finishing with the physical construction of a test-bed prototype of the hybrid vehicle," citing the Declaration of Mr. Davis. *Id.*

We cannot state, as a per se rule, that Petitioner's atypical approach can never be acceptable in any circumstance. Each case depends on its own facts. Bumby I is titled: "Computer modelling of the automotive energy requirements for internal combustion engine and battery electric-powered vehicles." Ex. 1905, 1. Petitioner explains that Bumby I discloses the workings of a software tool called the "Janus simulator."[4] Pet. 12. The Janus simulator was developed for simulating either a conventional vehicle or a hybrid vehicle. Ex. 1905, 2. Petitioner explains that the Janus simulator provides a formula for determining the "net tractive effort" required at the road wheels, and also that that tractive effort is what the '634 patent regards as "road load" or "instantaneous torque required for propulsion of the vehicle." Pet. 13.

Petitioner explains that Bumby II describes using the Janus simulator disclosed by Bumby I for optimizing the power train control and component

[4] Bumby I states that its computer modelling program was given the name "Janus." Ex. 1905, 2.

rating of a hybrid electric vehicle. *Id.* Indeed, citing Bumby I, Bumby II states: "To implement the optimisation process, the hybrid vehicle is simulated over a defined driving cycle using the Janus road vehicle simulation program [15]." Ex. 1906, 4. In the Initial Decision, we determined that the evidence supports the view that all that is disclosed in Bumby I is adopted for use in Bumby II. Dec. Inst. 14. Here, we find by a preponderance of the evidence that all that is disclosed in Bumby I is adopted for use in Bumby II.

Petitioner explains that "[b]ased on the prior hybrid vehicle work, Bumby V focused on the 'additional component control problems relating to engine and motor torque control and smooth engine starting.'" Pet. 18. Bumby V specifically refers to the optimization results of Bumby II, which solved certain problems, and states: "In this paper the additional component control problems relating to engine and motor torque control and smooth engine starting are addressed." Ex. 1909, 3. In the Initial Decision, we determined that the evidence supports the view that all that is disclosed in Bumby II is adopted for use in Bumby V. Dec. Inst. 14. Here, we find by a preponderance of the evidence that all that is disclosed in Bumby II is adopted for use in Bumby V.

As noted by Petitioner (Pet. 20), referring specifically to Bumby III, titled "A hybrid internal combustion engine/battery electric passenger car for petroleum displacement," Bumby V states that "[b]y correct design," such a drive arrangement not only has the potential to reduce exhaust emissions in the urban environment substantially, but also of substituting up to 70% of

the petroleum fuel used by the average road user. Ex. 1909, 2. That language indicates agreement with the design disclosed in Bumby III. In the Initial Decision, we determined that the evidence supports the view that all that is disclosed in Bumby III is adopted for use in Bumby V. Dec. Inst. 14. Here, we find by a preponderance of the evidence that all that is disclosed in Bumby III is adopted for use in Bumby V.

Bumby IV is titled: "A test-bed facility for hybrid ic-engine/battery-electric road vehicle drive trains." Ex. 1908, 2. Bumby V describes that satisfactory performance of the completed controllers is confirmed by using an extensive laboratory test facility, and that a complete description of the test bed facility is given in Bumby IV. Ex. 1909, 3. In the Initial Decision, we determined that the evidence supports the view that all that is disclosed in Bumby IV is adopted for use in Bumby V. Dec. Inst. 15. Here, we find by a preponderance of the evidence that all that is disclosed in Bumby IV is adopted for use in Bumby V.

Regardless of whether there was a common project, the disclosures of Bumby I, II, III, IV, and V represent incremental development of technology that builds from one to the next, and which one with ordinary skill in the art would have recognized as follow-on works adaptable for use collectively. They liken to successive pages in an instruction manual or chapters in a textbook. In that context, expressly specifically articulating a difference between the claimed invention and each Bumby reference is not essential, as the differences are implicit based on what Petitioner has cited to in each reference.

Based on the foregoing, the particular facts of this case are sufficient to support Petitioner's position regarding Bumby I, II, III, IV, and V, collectively, as a combination, and treating Bumby I, II, III, and IV as though all their teachings are adopted for use in Bumby V, without need for expressing additional reasons to combine teachings, on a limitation by limitation basis. To the extent that Patent Owner has raised a "teach away" argument, Petitioner properly may address the issue in its Reply, and it has. We treat Patent Owner's "teach away" argument in our substantive analysis below.

The same is not true, however, with respect to Masding as an additional member of the collection. Petitioner does not identify any reference in Bumby V to Masding. According to Petitioner, Masding provides a full citation to Bumby V, but Bumby V is subsequent to Masding. It appears that Masding does identify in its bibliography an unpublished but "submitted" version of Bumby V. Ex. 1910, 253. But no copy of that pre-published version was included with the Petition, and Petitioner does not identify any substantive description in Masding about Bumby V. The record does not support that all the disclosures of Masding are implemented in the hybrid vehicle described in Bumby V, or that all the disclosures of Bumby V are adopted or incorporated for use in Masding.

With regard to Bumby I, Bumby II, and Bumby III, and Masding, Petitioner states:

> Masding provides a section titled "The Context of the Present Work" that chronologically details the Durham Project. (Ex. 1910 [Masding Thesis] at 38-47.) Within this section, Masding

> discusses and **expressly references** the work published in Bumby I, Bumby II, and Bumby III. (Ex. 1910 [Masding Thesis] at 38-40, 43.)

Pet. 20. We have reviewed the cited portion of Masding. It only generally summarizes what each of Bumby I, Bumby II, and Bumby III was about. Masding does state that it is the practical component control problems raised by the sub-optimal control strategy of Bumby II which provided the motivation for the work described "in this thesis." Ex. 1910, 43. That, however, does not convey anything specific about what disclosure in Bumby II, if any, is related to Masding.

Although Masding does indicate that the test-bed facility described in Bumby IV is used for the testing it employs (Ex. 1910, 53), that is insufficient to support the approach taken by Petitioner which assumes (1) that all of the disclosures of Bumby I, II, and III are adopted or incorporated for use in Masding, (2) that all of the disclosures of Masding are adopted or incorporated for use in Bumby V, and (3) that all of the disclosures of Bumby V are adopted or incorporated for use in Masding.

Accordingly, we determine that Petitioner has not articulated sufficient reasons to combine the teachings of Masding with those of Bumby I, II, III, IV, and V. Petitioner's citations to Masding's disclosure, if necessary to meet the claim limitations, are improper and should not be considered. Our substantive analysis below will exclude the teachings from Masding, to the extent that they have been combined by Petitioner to meet the challenged claims. We also will discount the testimony of Dr. Davis, to the extent that it relies on any teaching from Masding for support.

C. Claims 161, 172, 215, 226, 230, and 234 as Obvious, over Bumby I, Bumby II, Bumby III, Bumby IV, Bumby V, and Masding

As explained above, Petitioner has failed to articulate sufficient reasoning to combine the teachings of Masding with those of Bumby I, II, III, IV, and V. Thus, we analyze these claims on this ground of unpatentability *without* any teaching from Masding that has been relied on by Petitioner. For reasons discussed below, we conclude (1) that Petitioner is estopped from continuing to maintain the challenge against claims 161 and 215, and (2) that Petitioner has shown, by a preponderance of the evidence, that claims 172, 226, 230, and 234 are unpatentable as obvious over Bumby I, II, III, IV, V, and Masding.

Patent Owner does not explicitly take a position on the level of ordinary skill in the art. Petitioner states that the level of ordinary skill in the art is evidenced by the references and expresses a certain required level of technical education and experience. Pet. 6. We determine that no express finding on a specific corresponding level of technical education and experience is necessary, and that the level of ordinary skill in the art is reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

1. Claims 161 and 215

Citing 35 U.S.C. § 315(e)(1), Patent Owner asserts that Petitioner may not maintain its challenge of claims 161 and 215 after the Board enters a final written decision on those claims in IPR2014-01416. PO Resp. 15. We agree.

Specifically, section 315(e)(1) provides:

(e) Estoppel.—

> **(1) Proceedings before the Office.**—The petitioner in an inter partes review of a claim in a patent under this chapter that results in a final written decision under section 318(a) . . . may not request or maintain a proceeding before the Office with respect to that claim on any ground that the petitioner raised or reasonably could have raised during that inter partes review.

A final written decision was entered in IPR2014-01416 on March 10, 2016, in which we determined that both claims 161 and 215 of the '634 patent, among other claims, are unpatentable. Petitioner in this proceeding was also the Petitioner in IPR2014-01416. The grounds raised by Petitioner in IPR2014-01416 against claims 161 and 215 were not the same as the grounds raised against those two claims in this proceeding. Whether to apply estoppel turns on whether Petitioner reasonably could have raised the prior art asserted here, i.e., Bumby I, II, III, IV, V, and Masding, in IPR2014-01416. We find that Petitioner reasonably could have.

Bumby I, II, III, IV, and V were known to Petitioner as early as April 4, 2014, when Petitioner filed a petition for *inter partes* review against certain claims of U.S. Patent No. 7,104,347 B2, in IPR2014-00579. In IPR2014-00579, Petitioner alleged that claims 1, 7, 8, 18, 21, 23, and 37 of

U.S. Patent No. 7,104,347 B2 are unpatentable over Bumby I, Bumby II, Bumby III, Bumby IV, and Bumby V. The Petition in IPR2014-01416 was filed on August 29, 2014, almost five full months after filing of the petition in IPR2014-00579. Thus, at the time of filing of the Petition in IPR2014-01416, Petitioner reasonably could have included, for claims 161 and 215, a ground of unpatentability that is based on Bumby I, II, III, IV, and V.

We recognize that the ground of unpatentability at issue in this proceeding is not just Bumby I, II, III, IV, and V, but Bumby I, II, III, IV, V, *and* Masding, but that is inconsequential for two reasons. First, Petitioner "reasonably could have" uncovered Masding by August 29, 2014, because Petitioner presents Masding as a printed publication with a publication year of 1989, and also because Petitioner has not asserted any special difficulty in obtaining access to Masding. Second, as will be discussed below, as presented by Petitioner no teaching from Masding is required for rendering unpatentable claims 161 and 215. The alleged ground of unpatentability for these two claims effectively is based solely on Bumby I, II, III, IV, and V.

Petitioner argues that estoppel should not be applied against its assertion of unpatentability against claims 161 and 215 in this proceeding, noting that its Petition challenges claims which depend from claims 161 and 215 and that the dependent claims incorporate the limitations of the claims from which they depend. Reply 5–6. We are unpersuaded by the argument, because regardless of whether the dependent claims include the limitations of the claims on which they depend, Petitioner may challenge only the dependent claims without challenging the independent claims, and also

because the dependent claims may be cancelled, if determined as unpatentable, without also cancelling the claims from which they depend. It is unnecessary that we make a formal determination of patentability with regard to claims 161 and 215 to rule on the claims dependent therefrom.

Accordingly, Petitioner is estopped from maintaining a challenge as to claims 161 and 215 of the '634 patent. We dismiss the *inter partes* review with respect to claims 161 and 215.

2. Claim 172

Claim 172 depends from claim 161, and thus includes all of the limitations of claim 161. We have reviewed the arguments and evidence presented by Petitioner, and determine that notwithstanding the arguments of Patent Owner, which we discuss below, Petitioner has established, by a preponderance of the evidence, that claim 172 would have been obvious over the combined teachings of Bumby I, II, III, IV, and V. This showing of unpatentability is unchanged even if viewed within the framework of the alleged combination of Bumby I, II, III, IV, V, and Masding. Accordingly, we determine that Petitioner has established, by a preponderance of the evidence, that claim 172 would have been obvious over the combined teachings of Bumby I, II, III, IV, V, and Masding, as alleged by Petitioner, even though no teaching from Masding has been relied on for making this determination.

In what Petitioner regards as limitation [161.0], claim 161 recites: "A method for controlling a hybrid vehicle, comprising." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs

246–253 and 413 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 23, 51. We find that this limitation is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [161.1], claim 161 recites: "determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 247–262 and 414 of the first Declaration of Mr. Davis (Ex. 1903). Pet. 23–26, 52.

Petitioner refers to Bumby II as disclosing a control strategy that selects the mode of operation based on the actual torque and speed values needed to propel the vehicle. *Id.* at 23. Petitioner identifies (*id.* at 24) Bumby II's Figure 16 (reproduced below) as showing three different modes of vehicle operation: (1) engine-only mode in Region B; (2) [electric] motor-only mode in Region A; and (3) engine-motor hybrid mode in Region C:

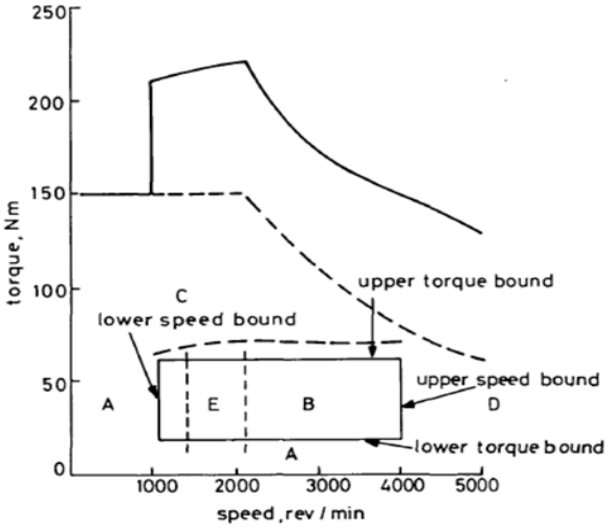


Fig. 16 *Parallel hybrid suboptimum control operating regions*
(A) All electric region
(B) All IC engine
(C) Hybrid region
(D) Operation not allowed
(E) Reduced suboptimum region

The above Figure 16 illustrates the control policy used in Bumby II. Ex. 1906, 11. As shown in Figure 16, at any given speed between a lower and upper speed bound, the vehicle changes operational mode based solely on its torque requirement. That strategy is further explained in Bumby II and Bumby III. Ex. 1906, 10–11; Ex. 1907, 7–8. In particular, Bumby III states:

> To develop a control algorithm that can be implemented on an actual vehicle a sub-optimal control algorithm is postulated that seeks to restrict the operation of the i.c. engine to the high efficiency region. This algorithm accepts demand power as its control variable and, by sensing road speed, *transforms this power to a torque at the output of the transmission*. Demand power, as far as the simulation is concerned, is simply transmission output power, *but in reality would be driver-demand power, expressed as a function of accelerator pedal position*.

Ex. 1907, 7 (emphasis added). To complete the control picture, Bumby III also further describes operations with parameters falling outside of the control "box"[5] featured in Figure 16. Specifically, Bumby III states:

> The control algorithm always seeks to place the i.c. engine operating point within the "box" using the available transmission ratios. If no points occur in the box and all points fall below or to the left of the box, then the electric mode of operation is selected. If all points occur above the box then primary i.c. engine operation is selected with the i.c. engine set at about 90 per cent throttle (to maximize engine efficiency) with the electric traction system making up the additional torque requirement.

[5] The so called "box" is the rectangular configuration delimited by solid lines in the middle of Figure 16 of Bumby II as shown above.

Id. at 7–8. Bumby V further clarifies that in the hybrid vehicle the torque demand as reflected by the driver's pressing the accelerator or brake pedal is intercepted by a hybrid-mode control unit. Ex. 1909, 13. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 259–262 of the first declaration of Dr. Davis (Ex. 1903). We find that limitation [161.1] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.2], claim 161 recites: "wherein the hybrid vehicle is operated in a plurality of operating modes corresponding to values for the RL and a setpoint (SP)." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 246–287, 305–308, 341–345, and 415 of the first declaration of Dr. Davis (Ex. 1903). Pet. 23, 32–33, 36–37, 41, 52. Based on our construction of the term "setpoint," the control strategy shown in Bumby II's Figure 16 shows, in between a lower and upper speed bound, an all-electric mode A, all IC engine mode B, and hybrid or engine-motor mode C. The "lower torque bound" indicated in Figure 16 designates the setpoint (SP). Ex. 1906, 11. Petitioner's position is supported by the cited testimony of Dr. Davis, in particular paragraphs 341–345 of his first declaration (Ex. 1903). We find that limitation [161.2] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.3], claim 161 recites: "operating at least one first electric motor to propel the hybrid vehicle when the RL required to do so is less than the SP." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 269–272, 324, and 416 of the first declaration of Dr. Davis (Ex. 1903). Pet. 27–29, 52.

Based on our construction of the term "road load" or "RL," and as can be seen in the control strategy illustrated in Bumby II's Figure 16, when road load is less than setpoint SP, i.e., "lower torque bound," the vehicle is operating in all electric mode A. Petitioner's position is supported by the cited testimony of Dr. Davis, in particular paragraphs 269–272 of his first declaration (Ex. 1903). We find that limitation [161.3] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.4], claim 161 recites: "wherein said operating the at least one first electric motor to drive the hybrid vehicle composes a low-load operation mode I." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 269–272, 324, 346–351, and 417 of the first declaration of Dr. Davis (Ex. 1903). Pet. 27–29, 42, 52. We have construed "mode I" as "a mode of operation of the vehicle, in which all torque provided to the wheels are supplied by an electric motor." We have determined above that in the control strategy illustrated in Bumby II's Figure 16, when road load is less than setpoint SP, i.e., "lower torque bound," the vehicle is operating in all electric mode A. Petitioner's position is supported by the cited testimony of Dr. Davis, in particular paragraphs 346–351 of his first declaration (Ex. 1903). We find that limitation [161.4] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.5], claim 161 recites: "operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a

maximum torque output (MTO) of the engine." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 273–277, and 418 of the first declaration of Dr. Davis (Ex. 1903). Pet. 29–31, 52. Based on our construction of the term "road load" or "RL," and "SP," and as can be seen in the control strategy illustrated in Bumby II's Figure 16, when road load is between the "lower torque bound" as a setpoint and an "upper torque bound," the vehicle is operating in an all internal combustion engine mode B, albeit also between a lower and upper speed bound.

Bumby III describes that the "upper torque bound" is set to a value that is 90% of the engine's maximum torque output. Ex. 1907, 8. Bumby V indicates the same. Ex. 1909, 4. The "upper torque bound" is less than the maximum torque output (MTO) of the engine and thus limitation [161.5] is met by this control scheme. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 273–277 of his first declaration (Ex. 1903). We find that limitation [161.5] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.6], claim 161 recites: "wherein the engine is operable to efficiently produce torque above the SP." For that recitation, Petitioner cites to Bumby II and III, and also declaration paragraphs 278–280, and 419 of the first declaration of Dr. Davis (Ex. 1903). Pet. 31–32, 52. In Bumby II, it is indicated that inside the "box" of its Figure 16, which is above the setpoint, the internal combustion engine operates efficiently. Ex. 1906, 10–11. Bumby III indicates the same,

referring to its Figure 8. Ex. 1907, 7. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 278–280 of his first declaration (Ex. 1903). We find that limitation [161.6] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.7], claim 161 recites: "and wherein the SP is substantially less than the MTO." The Specification does not expressly define the meaning of what constitutes "substantially less." However, Petitioner identifies claim 15 of the '634 patent, which includes a similar limitation by way of claim 1 on which it depends, and specifically recites a setpoint that is less than approximately 70% of the MTO of the engine. Pet. 32, 52. According to claim 15, at levels above the setpoint, torque is produced efficiently by the engine. That is similar to what is required by claim 161, which recites: "wherein the engine is operable to efficiently produce torque above the [setpoint]." Considering the content of claim 15, we determine that substantially less than the MTO includes anything less than 70% of the MTO.

For this recitation, Petitioner cites to Bumby II, III, and IV, and also declaration paragraphs 281–287, 420 of the first declaration of Dr. Davis (Ex. 1903). Pet. 32–33, 52. Bumby IV discloses that the engine's MTO is "71 Nm [(Newton-meters)]." Ex. 1908, 5, Table 2. Bumby III discloses that the "upper torque bound" corresponding to Bumby II's Figure 16 is 90% of the MTO. Ex. 1907, 8. That makes the "upper torque bound" in the Figure around 64 Newton-meters. The Figure shows the "lower torque bound," which forms the SP, farther away from the 50 Newton-meters mark, in the

other direction, relative to the "upper torque bound," such that more of the "box" is below the 50 Newton-meters mark. Thus, the SP shown in the Figure is no greater than 36 Newton-meters, a level that is at approximately 51% of the MTO. Petitioner contends that a visual inspection of the Figure indicates that SP approximates the level at 20 Newton-meters, which reflects 30% of the MTO. Pet. 33. Whether the SP is at 30% or 51% of the MTO, one with ordinary skill in the art would have recognized that SP is substantially less than the MTO. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 281–287 of his first declaration (Ex. 1903). We find that limitation [161.7] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.8], claim 161 recites: "wherein said operating the internal combustion engine of the hybrid vehicle to propel the hybrid vehicle composes a high-way cruising operation mode IV." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 273–277, 352–356, and 421 of the first declaration of Dr. Davis (Ex. 1903). Pet. 29–31, 42–43, 52. We have construed "high-way cruising operation mode IV" as "a mode of operation in which all torque provided to the wheels are supplied by the internal combustion engine."

We have determined above that in the control strategy illustrated in Bumby II's Figure 16, in Region B within the "box" delimited by solid lines, the vehicle is operating solely from power produced by the internal combustion engine. *See also* Ex. 1907, 11–12; Ex. 1908, 3; Ex. 1909, 4. Petitioner's position is supported by the cited testimony of Dr. Davis, in

particular paragraphs 273–277 of his first declaration (Ex. 1903). We find that limitation [161.8] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.9], claim 161 recites: "operating both the at least one first electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 273–277, 305–308, and 422 of the first declaration of Dr. Davis (Ex. 1903). Pet. 36–37, 52. Bumby III discloses that the "upper torque bound" corresponding to Bumby II's Figure 16 is 90% of the MTO. Ex. 1907, 8. That makes the "upper torque bound" in the Figure less than the MTO. As shown in Bumby II's Figure 16 above, the hybrid mode in Region C, in which power from both the electric motor and internal combustion engine are used, applies above the "upper torque bound," including the region in which the RL exceeds the MTO. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 305–308 of his first declaration (Ex. 1903). We find that limitation [161.9] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.10], claim 161 recites: "wherein said operating both the at least one first electric motor and the engine to propel the hybrid vehicle composes an acceleration operation mode V." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 357–361, and 423 of the first declaration of Dr. Davis (Ex. 1903). Pet. 43–44, 52. We have construed "acceleration operation mode V" as "a mode of operation in which torque provided to the

wheels is supplied by the internal combustion engine and at least one electric motor." As shown in Bumby II's Figure 16 above, the hybrid mode in Region C, both the electric motor and internal combustion engine are used to power the vehicle. *See also* Ex. 1907, 11–12; Ex. 1908, 3; Ex. 1909, 4. Specifically, Bumby V describes that engine torque can be augmented by the electric motor "for rapid acceleration or hill climbing." Ex. 1909, 4. Bumby V describes that "the motor will be used to provide extra power if the engine output would otherwise exceed 90% of maximum, since this leads to inefficiency." *Id.* Petitioner's position is supported by the cited testimony of Dr. Davis, in particular paragraphs 357–361 of his first declaration (Ex. 1903). We find that limitation [161.10] is disclosed by Bumby I, II, III, IV, and V.

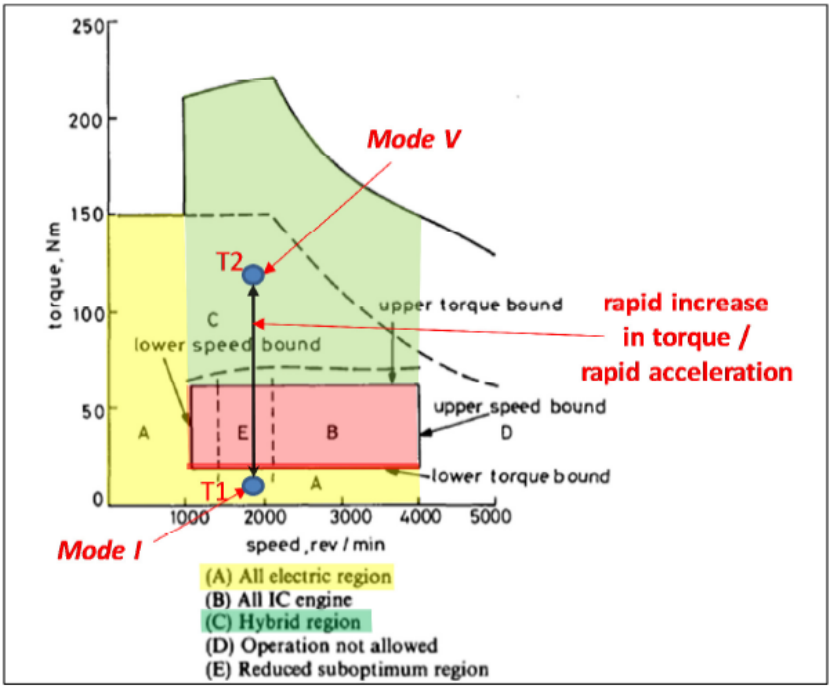
In what Petitioner refers to as limitation [161.11], claim 161 recites: "receiving operator input specifying a change in required torque to be applied to wheels of the hybrid vehicle." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 247–262, 371–374, and 424 of the first declaration of Dr. Davis (Ex. 1903). Pet. 23–26, 52. Specifically, Bumby V states: "the end result of the optimisation process is a mode controller which receives, as input, the driver's brake and accelerator signals and then adjusts the torque demand to the engine and motor to meet the total demand." Ex. 1909, 3. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 371–374 of his first declaration (Ex. 1903). We find that limitation [161.11] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner refers to as limitation [161.12], claim 161 recites: "if the received operator input specifies a rapid increase in the required torque, changing operation from operating mode I directly to operating mode V." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 375–381, and 425 of the first declaration of Dr. Davis (Ex. 1903). Pet. 23–26, 52–53.

Referring to an annotated version of Figure 16 of Bumby II, which depicts a transition from point T1 to point T2, Petitioner states:

> As a result of the *rapid increase in the required torque* during acceleration, the vehicle would change operation from motor-only mode (*i.e., mode I* shaded in yellow) *directly to* engine-motor mode (*i.e., mode V* shaded in green). (Ex. 1903 [Davis Dec.] at ¶¶ 375–381.

Pet. 46. The annotated Figure 16 is reproduced below:



Ex. 1906 [Bumby II] at 11, Fig. 16

The above annotated Figure 16 is the same as Bumby II's Figure 16, reproduced earlier, with coloring added to regions A, B, and C, and annotations added to denote a transition between two points T1 and T2 according to Petitioner. Petitioner's position is supported by the testimony of Dr. Davis. Ex. 1903 ¶¶ 375–379. In particular, Dr. Davis explains:

> For example, it would be obvious to a person of ordinary skill in the art that during a *rapid increase in required torque*, as I have annotated below, that the vehicle would switch directly from *mode I* to *mode V*. As I have annotated as "T1" below for instance, the torque required to propel the vehicle at constant speed in a fixed gear may be below the "lower torque bound" or *setpoint*. The vehicle would be operating in the motor-only mode where propulsion is provided by the electric motor. However, if at the same speed (again in a fixed gear) there is a rapid request for acceleration (e.g., the driver presses down the accelerator pedal a large amount) a person of ordinary skill in the art would understand a rapid increase in torque would result. Due to the rapid acceleration request, the torque required to propel the vehicle would move to the point I have annotated as "T2." This shift from "T1" to "T2" would result in the operational mode shifting from a motor-only mode to an engine-motor mode of operation. A person having ordinary skill in the art would have further understood that the control logic would not force the vehicle to stop in the engine-only mode region as the controller would not be providing the actual torque that is required to propel the vehicle.

Id. ¶ 379.

We find that Bumby I, II, III, IV, and V reasonably would have suggested limitation [161.12] to one with ordinary skill in the art. In making this conclusion, we have not accorded any weight to Petitioner's reliance on Masding (Pet. 47–48), and we have not considered paragraph 380 of the first

declaration of Dr. Davis (Ex. 1903) which discusses the disclosure of Masding with respect to this limitation, because Petitioner has not shown that Masding could have been combined with Bumby I, II, III, IV, and V.

Claim 172 incorporates the limitations of claim 161 and further recites: "wherein said engine can be operated without transmitting power to the wheels of the hybrid vehicle during operation in mode I." For that recitation, Petitioner cites to Bumby V and also declaration paragraphs 362–370 of the first declaration of Dr. Davis (Ex. 1903). Pet. 45, 53. Bumby V discloses that in all-electric mode, the internal combustion engine "will be uncoupled from the drive train by means of the one-way clutch." Ex. 1909, 5. Bumby V discloses a synchronization interval during which the engine is operated but not engaged with the drive-train and is ramped up to drive-train speed while an electric motor is operating. *Id.* at 6. Petitioner asserts that it would have been obvious to one with ordinary skill in the art that when the engine is not coupled to the drive-train, no power is transmitted to the wheels from the engine. Pet. 45. We agree. Petitioner's position is supported by the testimony of Dr. Davis, in particular paragraphs 362–370 of his first declaration (Ex. 1903). We find that the Bumby I, II, III, IV, and V reasonably would have suggested the limitation added by claim 172, relative to claim 161, to one with ordinary skill in the art.

We find Petitioner has shown that Bumby I, II, III, IV, and V collectively disclose or reasonably would have suggested each of the limitations of claim 172, and also that one with ordinary skill in the art would have recognized, for reasons discussed above regarding combinability

of teachings from Bumby I, II, III, IV, and V, that such disclosures are jointly applicable to the same hybrid vehicle.

3. Claim 226

Claim 226 depends from claim 215, and thus includes all of the limitations of claim 215. We have reviewed the arguments and evidence presented by Petitioner, and determine that notwithstanding the arguments of Patent Owner, which we discuss below, Petitioner has established, by a preponderance of the evidence, that claim 226 would have been obvious over the combined teachings of Bumby I, II, III, IV, and V. This showing of unpatentability is unchanged even if viewed within the framework of the alleged combination of Bumby I, II, III, IV, V, and Masding. Accordingly, we determine that Petitioner has established, by a preponderance of the evidence, that claim 226 would have been obvious over the combined teachings of Bumby I, II, III, IV, V, and Masding, as alleged by Petitioner, even though no teaching from Masding has been relied on for making this determination.

In what Petitioner regards as limitation [215.0], claim 215 recites: "A method for controlling a hybrid vehicle, comprising." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 246–253 and 428 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 23, 53. We find that this limitation is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.1], claim 215 recites: "determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command." For that recitation, Petitioner

cites to Bumby II, III, and V, and also declaration paragraphs 247–262 and 429 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 23–26, 53. Limitation [215.1] is the same as limitation [161.1]. For the reasons discussed above with regard to limitation [161.1], we find that limitation [215.1] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.2], claim 215 recites: "operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP)." For that recitation, Petitioner cites to Bumby II, III, IV, and V, and also declaration paragraphs 269–272, 324, and 430 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 27–29, 53. Limitation [215.2] is the same as limitation [161.3]. For the reasons discussed above with regard to limitation [161.3], we find that limitation [215.2] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.3], claim 215 recites: "operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine." For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 273–277 and 431 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 29–31, 53. Limitation [215.3] is the same as limitation [161.5]. For the reasons discussed above with regard to limitation [161.3], we find that limitation [215.3] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.4], claim 215 recites: "wherein the engine is operable to efficiently produce torque above the SP."

For that recitation, Petitioner cites to Bumby II, III, and V, and also declaration paragraphs 278–280 and 432 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 31–32, 53. Limitation [215.4] is the same as limitation [161.6]. For the reasons discussed above with regard to limitation [161.6], we find that limitation [215.4] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.5], claim 215 recites: "wherein the SP is substantially less than the MTO." For that recitation, Petitioner cites to Bumby II, III, and IV, and also declaration paragraphs 281–287 and 433 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 32–33, 53. Limitation [215.5] is the same as limitation [161.7]. For the reasons discussed above with regard to limitation [161.7], we find that limitation [215.5] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.6], claim 215 recites: "operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO." For that recitation, Petitioner cites to Bumby II, III, and IV, and also declaration paragraphs 281–287 and 433 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 32–33, 53. Limitation [215.6] essentially is the same as limitation [161.9]. For the reasons discussed above with regard to limitation [161.9], we find that limitation [215.6] is disclosed by Bumby I, II, III, IV, and V.

In what Petitioner regards as limitation [215.7], claim 215 recites: "regeneratively charging a battery of the hybrid vehicle when instantaneous torque output of the engine>the RL, when the RL is negative, and/or when

braking is initiated by an operator of the hybrid vehicle." For that recitation, Petitioner cites to Bumby II, III, and IV, and also declaration paragraphs 382–392 and 437 of the first Declaration of Dr. Davis (Ex. 1903). Pet. 48, 53–54. Regeneratively charging the battery during any one of the three identified conditions satisfies the limitation. Bumby II, Bumby III, and Bumby IV each discloses regeneratively charging the battery upon braking. Bumby II describes that the electrical system seeks to accept regenerative braking energy. Ex. 1906, 5. Bumby III describes a "regenerative braking mode" that is used "to recover vehicle kinetic energy during braking." Ex. 1907, 4. Bumby IV refers to making regenerative braking into the battery "immediately available when required." Ex. 1908, 3. Petitioner's position is supported by the testimony of Dr. Davis. We find that limitation [215.7] is disclosed by Bumby I, II, III, IV, and V.

Claim 226 incorporates the limitations of claim 215 and further recites: "turning off the engine when the torque required to propel the vehicle is less than the SP." For that additional recitation, Petitioner cites to Bumby V and also declaration paragraphs 308–313 and 438 of the first declaration of Dr. Davis (Ex. 1903). Pet. 38–39, 54. In pertinent part, Bumby V states:

> Whenever the hybrid vehicle is operating in an all-electric mode or is stationary, the i.c.-engine will be uncoupled from the drive train by means of the one-way clutch. *Since in either of these situations the engine is not required to provide torque, the most obvious strategy is to shut it down entirely in order to conserve petroleum fuel*.

Ex. 1909, 5 (emphasis added). In that regard, we note that as discussed above when torque is less than the setpoint, the vehicle is operating in an all-electric mode according to the sub-optimal control algorithm of Bumby II. *See* Ex. 1906, Figure 16. Also, as is noted in the cited testimony of Dr. Davis (Ex. 1903 ¶ 311), Bumby IV states: "To improve power-train efficiency when the engine is not in use it is shut down." Ex. 1908, 7. Thus, we find that the limitation added by claim 226, relative to claim 215, is disclosed by Bumby I, II, III, IV, and V.

4. Claim 230

Claim 230 depends from claim 215, and thus includes all of the limitations of claim 215. We have reviewed the arguments and evidence presented by Petitioner, and determine that notwithstanding the arguments of Patent Owner, which we discuss below, Petitioner has established, by a preponderance of the evidence, that claim 230 would have been obvious over the combined teachings of Bumby I, II, III, IV, and V. This showing of unpatentability is unchanged even if viewed within the alleged combination of Bumby I, II, III, IV, V, and Masding. Accordingly, we determine that Petitioner has established, by a preponderance of the evidence, that claim 230 would have been obvious over the combined teachings of Bumby I, II, III, IV, V, and Masding, as alleged by Petitioner, even though no teaching from Masding has been relied on for making this determination.

Claim 230 incorporates the limitations of claim 215 and further recites: "wherein said operating the internal combustion engine of the hybrid vehicle to propel the hybrid vehicle and said operating both the at

least one electric motor and the engine to propel the hybrid vehicle, each comprises: if the engine is not already running, starting the engine." For that recitation, Petitioner cites to Masding and also declaration paragraphs 316–321 and 439 of the first declaration of Dr. Davis (Ex. 1903). Pet. 39–40, 54. We have, however, determined that Petitioner has not provided sufficient rationale to combine the teachings of Masding with that of Bumby I, II, III, IV, and V. Therefore, we will disregard, for purposes of Petitioner's arguments with regard to this limitation that are based on Masding.

Dr. Davis refers to Bumby V in his first declaration, in addition to Masding. Ex. 1903 ¶¶ 317, 320. Notably, Bumby V states: "Adopting this strategy means that the next time the engine is required it must be started and synchronised [sic] with the moving, and possibly accelerating, drive train, before it can replace or augment the torque supplied by the electric traction system." Ex. 1909, 5. Bumby V further states: "When required, the warm engine will fire in, typically 250 ms using the conventional electric starter motor, but there is a further delay while the engine accelerates up to the drive-train speed." *Id.* at 6. Thus, we find that the limitation added by claim 230 relative to claim 215 is disclosed by Bumby I, II, III, IV, and V.

The limitations of claim 215 that are incorporated into claim 230 have been accounted for by Petitioner, as discussed above. We find that Bumby I, II, III, IV, and V collectively disclose or reasonably would have suggested each of the limitations of claim 230, and that one with ordinary skill in the art would have recognized, for reasons discussed above regarding

combinability of teachings from Bumby I, II, III, IV, and V, that such disclosures are jointly applicable to the same hybrid vehicle.

5. Claim 234

Claim 234 depends from claim 215, and thus includes all of the limitations of claim 215. We have reviewed the arguments and evidence presented by Petitioner, and determine that notwithstanding the arguments of Patent Owner, which we discuss below, Petitioner has established, by a preponderance of the evidence, that claim 234 would have been obvious over the combined teachings of Bumby I, II, III, IV, and V. This showing of unpatentability is unchanged even if viewed within the alleged combination of Bumby I, II, III, IV, V, and Masding. Accordingly, we determine that Petitioner has established, by a preponderance of the evidence, that claim 234 would have been obvious over the combined teachings of Bumby I, II, III, IV, V, and Masding, as alleged by Petitioner, even though no teaching from Masding has been relied on for making this determination.

Claim 234 incorporates the limitations of claim 215 and further recites: "wherein the engine can be operated without transfer of power to the wheels of the hybrid vehicle during operation in mode I." For that recitation, Petitioner cites to Bumby V and also declaration paragraphs 362–370 and 444 of the first declaration of Dr. Davis (Ex. 1903). Pet. 45, 55. This added limitation is essentially the same as the limitation added by claim 172 relative to claim 161. For the reasons discussed above in the context of claim 172, we find that the limitation added by claim 234 relative to claim 215 reasonably would have been suggested by Bumby I, II, III, IV, and V.

We find Petitioner has shown that Bumby I, II, III, IV, and V collectively disclose or reasonably would have suggested each of the limitations of claim 234, and also that one with ordinary skill in the art would have recognized, for reasons discussed above regarding combinability of teachings from Bumby I, II, III, IV, and V, that such disclosures are jointly applicable to the same hybrid vehicle.

6. Patent Owner's Contentions

Patent Owner makes three contentions a, b, and c: (a) that Petitioner still relies on Masding to meet the limitations of all challenged claims in this trial; (b) that Bumby I, II, III, IV, and V do not disclose using road load (RL) and a setpoint (SP) to determine when to operate the engine; and (c) that Bumby IV and Bumby V teach away from Bumby II and Bumby III. PO Resp. 38, 15–32, 39–42. The second contention (b) has four parts i, ii, iii, and iv: (i) that the Bumby references do not compare a road load (RL) to a setpoint (SP); (ii) Petitioner's discussion of "torque at the drive wheels" is misleading; (iii) Petitioner's and its expert Dr. Davis's description of the "sub-optimal control algorithm" of Bumby II and Bumby III is inaccurate; and (iv) the sub-optimal control algorithm of Bumby II and Bumby III is fundamentally different from the claimed control strategy. *Id.* at 16–32.

We address Patent Owner's arguments in the sequence and structure as noted above.

a) That Petitioner Relies on Masding

Patent Owner points out that in the Initial Decision we determined that Petitioner failed to set forth sufficient reasoning for combining the

teachings of Masding with those of Bumby I, II, III, IV, and V. PO Resp. 37–38. Patent Owner then asserts that Petitioner has relied on Masding to meet two limitations of all challenged claims in this trial, i.e., (1) "operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint," and (2) "operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine." *Id.* at 38. The first corresponds to limitations [161.3] and [215.2], and the second corresponds to limitations [161.5] and [215.3].

The Patent Owner's argument is unpersuasive. Although with respect to these limitations, Petitioner did cite to Masding (Pet. 27, 30), the reliance on Masding was unnecessary, as it was additional to Petitioner's citations to and reliance on Bumby II, III, IV, and V with respect to limitations [161.3] and [215.2], and citations to and reliance on Bumby II, III, and V with respect to limitations [161.5] and [215.3]. In our analysis above with regard to these limitations, we did not rely on any teaching from Masding.

b) That Bumby I, II, III, IV, and V do not Disclose Using Road Load (RL) and a Setpoint (SP) to Determine When to Operate the Engine

i.

Patent Owner argues:

> The Bumby references do not disclose "operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and [the] maximum torque output (MTO) of the engine," or other limitations requiring [comparison of] road load and setpoint, as required by claims 161, 215, and all claims depending therefrom

> (which includes all instituted claims). Ex. 2904 at § IX.A. Instead, Bumby II and Bumby III (on which [Petitioner] principally relies) disclose a fundamentally different control strategy that uses *demand power*, *calibrated by the pedal position*, and the *available gear ratios* to determine whether to use the engine to propel the vehicle.

PO Resp. 16. Patent Owner explains that the sub-optimal control algorithm of Bumby II and III, shown in Figure 16 of Bumby II, "calculates demand power based on pedal position, and compares that value to a range of power values available based on the vehicle's gear ratios." *Id.* at 17. Patent Owner further explains that by taking the driver's pedal position as control input, and "[b]y then taking into account the vehicle speed and available gear ratios, the sub-optimal control algorithm [of Bumby II and III] determines a series of torque and drive shaft speed pairs (one for each available gear) that could be input into the transmission to meet the demand power as calibrated by pedal position." *Id.* Patent Owner acknowledges that if any of the power values that the available gear ratios can produce fall within the "box" in Figure 16 of Bumby II, the sub-optimal control algorithm selects the gear ratio that will result in a power value within the "box," and sets the demand power to be met by the engine only. *Id.* at 18. Patent Owner also acknowledges that if all power values that the available gear ratios can produce fall above the "box," the electric motor and the engine are used to meet the demand. *Id.* According to Patent Owner, however, because the object of comparison is a "power value," and not a torque value, the control algorithm of Bumby II and III does not compare road load to a setpoint.

Patent Owner's argument is unpersuasive. It is undisputed that "power" is determined as the multiplicative product of "torque" and "speed." A comparison directed to a selected power point on Figure 16 of Bumby II necessarily makes a comparison with regard to the torque value associated with the selected power point on the chart, regardless of whether a comparison also is made with respect to speed. Although there is a speed component to each power point, as we stated above in the claim construction portion of this opinion, we agree with Patent Owner that the claims require a comparison of road load (RL) to a setpoint (SP) and also to a maximum torque output (MTO), but that does not mean the claims exclude the comparison of other parameters. Indeed, they do not. The scope of these claims does not dictate that the only comparison made is with respect to torque, and that no other types of comparisons are involved.

As Petitioner properly notes, Bumby II and Bumby III describe that "demand power" as determined from pedal position is converted to a torque value. Reply 9. In that regard, Bumby III states, with respect to "demand power" as a control variable, that the algorithm "transforms this power to a torque at the output of the transmission." Ex. 1907, 7. Bumby II states: "the suboptimal control algorithm converts the instantaneous power and speed requirements into a torque and speed demand, at the torque split point for each available gear ratio." Ex. 1906, 11. Thus, the "demand power" is the means by which the sub-optimal control algorithm determines the desired torque to be applied to the wheels of the vehicle. Nothing in the claims precludes determining the desired torque in that manner. We find, as

asserted by Petitioner (Reply 9 (citing Ex. 1951 ¶¶ 12–14)), that a person of ordinary skill in the art would have understood that "demand power" is converted to torque based on the known mathematical relationship that power = torque * speed. After that conversion has been made, as is described by Petitioner and discussed above in the context of specific claims, the vehicle's mode of operation is selected based on the value of the determined torque, as compared to a setpoint and a MTO, notwithstanding that the selection also depends on determined speed.

Patent Owner argues that given a driver's pedal position as control input, Bumby's sub-optimal control algorithm attempts to operate the engine within a range of power demand values based on the available gear ratios, and thus that indicates a comparison is made relative to power and not torque. PO Resp. 19. The argument is misplaced because, again, it does not consider the fact that the selected power value based on available gear ratio represents a way to select and arrive at the desired torque value. It also does not change the fact that once determined, the desired torque value would be compared with a setpoint and an MTO to determine the mode of operation of the hybrid vehicle. Patent Owner's focus on the algorithm's initial determination of a power value corresponding to driver's pedal position is misplaced. As discussed above, that power value is subsequently converted into a torque value for comparison with a setpoint and a MTO. Just knowing the demand power is ineffective for determining any selection. Citing the testimony of Dr. Davis (Ex. 1951 ¶¶ 15–18), Petitioner persuasively argues that a person of ordinary skill in the art would have understood that because

a desired torque value is within the box, in Region B as shown in Figure 16 of Bumby II, the engine is used to operate the vehicle. Reply 12.

Thus, the Bumby references compare calculated torque values against the "lower torque bound" to determine whether the engine and/or electric motor should be used for propelling the vehicle. When the torque value is above the lower torque bound, the engine is used to propel the vehicle, and when the torque value is below the lower torque bound, the electric motor is used to propel the vehicle. Ex. 1906, 10–11, Fig. 16; Ex. 1907, 7–8, Fig. 8.

ii.

Patent Owner asserts that Petitioner's discussions directed to the disclosure in the Bumby references of determination of torque at the drive wheels is misleading. PO Resp. 19–23. We are unpersuaded.

First, Patent Owner argues that the "complete vehicle component control system" of Bumby V is separate and distinct from the sub-optimal control strategy of Bumby II and Bumby III and further does not describe determining the torque required to propel the vehicle at the drive wheels. *Id.* at 20. According to Patent Owner, the control system of Bumby V merely provides "a simple *speed-based* hybrid-mode controller for test purposes" that "determines whether to propel the vehicle with the engine or the motor based on speed, and provides a transmission gear-change command." *Id.* at 20–21. We have considered the cited testimony of Mr. Hannemann (Ex. 2904), which Patent Owner relies on in support of its argument. However, the argument is unpersuasive.

As we already determined above, the disclosures of Bumby II and Bumby III have been adopted for use within Bumby V. Thus, Bumby V need not reiterate what is already described in Bumby II and Bumby III. As is noted by Petitioner (Reply 13), Bumby V explains that the testing described therein is performed using an "arbitrary speed-based mode controller" that is "intended purely to demonstrate" that the control system illustrated by Bumby V's Figure 16 "is capable of following the dictates of any more sophisticated control strategy such as those described in [Bumby II]." Ex. 1909, 19. Also as is noted by Petitioner (Reply 13), like Bumby II and Bumby III, Bumby V pertains to providing a "torque control system." Ex. 1909, 2 ("Torque control systems for the internal-combustion engine and the electric-traction motor are designed using digital transfer functions and indirect methods of torque measurement."). Further, as noted by Petitioner (Reply 13), Bumby V states: "The job of the P+I speed controller is to map varying speed demands to appropriate torque demands." Ex. 1909, 15. The evidence simply does not support Patent Owner's contention that Bumby V contemplates only a speed-based control system.

Second, Patent Owner argues that certain portions of Petitioner's reliance on Bumby II and Bumby III, i.e., the "optimization process" and "optimal control," is misleading because the optimization process is not a control algorithm but "an obscure mathematical model that Bumby II and Bumby III use to optimize the output "of a discontinuous and highly non-linear objective function." PO Resp. 21. Patent Owner further argues that this optimization process is separate and distinct from the sub-optimal

control algorithm, and that it is because the optimization process is too computationally intensive to be useful in an actual vehicle, the authors of Bumby II and Bumby III developed the sub-optimal control algorithm which uses demand power as a control parameter. *Id.* at 22–23.

Petitioner contends, on the other hand, that the "optimization process" and the sub-optimal control algorithm are not unrelated. Petitioner explains:

> Bumby II & III begin by using the "optimization process" to evaluate how a hybrid vehicle configuration could be controlled and devised what was coined as the "optimum control strategy." (Ex. 1906, Bumby II at 4–5; Ex. 1907, Bumby III at 3 & 5.) But it was determined that the "optimal control policy cannot be easily implemented because of the substantial computing time required by the direct search technique and the frequent gear shifting required." (Ex. 1906, Bumby II at 10.) The "description of the optimization process" was therefore "followed by a method of translating the resulting control structure into a sub-optimum control algorithm capable of being implemented in real time." (Ex. 1907, Bumby III at 3.)
>
> This translation process involved "examining the engine usage data" for the "optimum control algorithm" and noting that IC engine operation was selected "whenever an operating point can be obtained close to the high-efficiency region." (Ex. 1906, Bumby II at 10.) Ultimately, the engine usage data resulted in defining the "engine operating box" shown in Bumby II/III. (Ex. 1906, Bumby II at 11, Fig. 16; Ex. 1907, Bumby III at 8, Fig. 8.) Bumby II/III then illustrated test results after the Janus software was further used to simulate the sub-optimal control algorithm over the ECE-15 driving cycle.[ ] (Ex. 1906, Bumby II at 11, Fig. 17, Ex. 1907, Bumby III at 9, Fig. 9.)

Reply. 16–17. Based on the foregoing, Petitioner contends that the sub-optimal control algorithm is not unrelated to or separate from the optimization process. *Id.* at 17–18. Petitioner's position is that the sub-

optimal control strategy is within the umbrella of the optimization process.

The debate as outlined above, whether the sub-optimal control strategy is separate from or within the umbrella of the overall "optimization process," is not meaningful. What satisfies the comparison requirements of the claims is the sub-optimal control algorithm as illustrated in Figure 16 of Bumby II. Petitioner relies specifically on the sub-optimal control strategy to meet the comparison requirements of the claims. *See*, *e.g.*, Pet. 23–27, 29–32, 36–37. Whether that algorithm is or is not nominally within the overall "optimization process" is inconsequential.

iii.

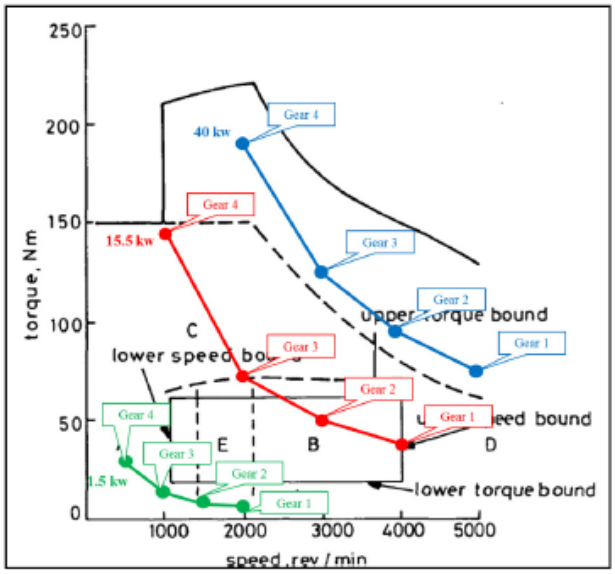
Patent Owner argues that Petitioner's and Petitioner's expert Dr. Davis's description of the sub-optimal control algorithm of Bumby II and Bumby III "fundamentally misrepresents" how that algorithm works by "selectively (and incorrectly) annotating Fig. 16 from Bumby II," referencing, for example, page 31 of the Petition. PO Resp. 23. Specifically, Patent Owner states: "Importantly, the horizontal axis of the figure is not 'vehicle speed,' but the speed, in revolutions per minute (*i.e.*, 'speed, rev / min'), of the drive shaft, before being input into the transmission." *Id.* Petitioner denies that any such annotation referring to "vehicle speed" has been made in this proceeding, and suggests that Patent Owner's contention is an artifact left over from IPR2014-00579. Reply 18. We have reviewed the Figure produced on page 31 of the Petition, and do not see the annotation referred to by Patent Owner. Instead, the horizontal

axis is labeled, as Patent Owner believes is accurate, "speed, rev / min." Thus, Patent Owner's argument is unpersuasive.

Patent Owner argues that the example provided by Petitioner on page 31 of the Petition is inapposite. PO Resp. 24. Specifically, Patent Owner states:

> Moreover, Ford's assumption that one can simply fix the gear in the sub-optimal control algorithm is incorrect and defeats the entire purpose of the algorithm, which is principally to select a gear. Ex. 2904 at ¶ 76. Indeed, neither Ford nor Dr. Davis provides any evidence that such a revision of the "sub-optimal" control algorithm . . . is clearly an exercise driven by impermissible hindsight.

Id. Patent Owner's argument is misplaced. Although the sub-optimal control algorithm is used to select an appropriate gear, there also is an aspect to it that relates to the selection of an operational mode for a hybrid vehicle. Because the Patent Owner's claims are directed to selecting an operational mode for the hybrid vehicle, and not to the selection of any gear, we do not find inappropriate Petitioner's hypothetical example making use of a fixed gear, e.g., only one gear is available. Although the hypothetical example is a simplified example, it is not an inappropriate one. It more readily illustrates how the hybrid-vehicle's operational mode would be selected, according to the algorithm, by removing a parameter that does not matter in the context of the claims. Moreover, we have considered the alternative annotated example provided by Patent Owner on page 26 of the Patent Owner Response, which is reproduced below:



The Figure represents Patent Owner's illustration of the sub-optimal control algorithm. It does not show anything meaningfully different from Petitioner's illustration. For instance, at power level 1.5 kW, all power points are outside of the "box," and in Region A, in which case the vehicle would be operating in all all-electric mode. At power level 15.5 kW, two points are within the "box" and in Region B, the algorithm would select one of these two points and the vehicle would operate by using only the internal combustion engine.[6] At power level 40 kW, all points are outside of the "box," and in Region C, the vehicle would use both the internal combustion engine and an electric motor to operate. These illustrations do not refute, and even confirm, what Petitioner asserts about that aspect of the sub-optimal control strategy relating to control of operational modes.

[6] Patent Owner acknowledges that the sub-optimal control will attempt to select the gear that falls within the box. PO Resp. 26.

Patent Owner also faults Petitioner's hypothetical example for assuming a constant vehicle speed. PO Resp. 27. For essentially the same reasons above that we find nothing wrong with Petitioner's assuming a fixed gear in its hypothetical example, we see nothing wrong with Petitioner's assuming a constant vehicle speed in the same example. The point of the example simply is to show what happens to a vehicle's operational mode as the applicable conditions fall within Regions A, B, and C, respectively. As noted above, the example provided by Patent Owner on page 26 of the Patent Owner Response and, as discussed above, does not show something meaningfully different from that in Petitioner's hypothetical example.

Patent Owner again argues that in the sub-optimal control algorithm, the control input is demand power and not road load. *Id.* at 28–29. However, as explained above in the discussion of what is compared by the algorithm, although the sub-optimal control algorithm begins with calculating demand power, that demand power is then converted to a specific selected torque value. Thus, the argument is misplaced.

Patent Owner argues that the sub-optimal control algorithm of Bumby II and Bumby III "is actually a transmission control system based on power." *Id.* at 25. This argument substantially overlaps with Petitioner's argument that the sub-optimal control algorithm is "fundamentally different" from what Patent Owner has claimed, which is discussed in the next subsection.

iv.

Patent Owner argues that the sub-optimal control algorithm of Bumby II and Bumby III is fundamentally different from Patent Owner's claimed control strategy. PO Resp. 29–33. First, Patent Owner argues that although its claimed control system may include a transmission system, the Specification of the '634 patent indicates that a transmission is "unnecessary." *Id.* at 29. Patent Owner further argues that, in contrast, the "sub-optimal control algorithm" of Bumby II and Bumby III "is at its core *a transmission control system*, and in fact, as explained above, relies on power requirements to select an efficient gear." *Id.* Patent Owner summarizes this argument as follows: "Selection of the correct gear to produce a given power output is a fundamentally different method of controlling a hybrid vehicle than the '634 patent's use of 'road load' and 'setpoints.'" *Id.*

We are unpersuaded, and Patent Owner's argument is misplaced. Even if the sub-optimal control algorithm fairly can be characterized as "at its core" a transmission control system, that does not take away or undermine its teachings about controlling the use of an internal combustion engine, one or more electric motors, or both. A prior art reference must be considered for everything it teaches by way of technology and is not limited to the particular invention it is describing and attempting to protect. *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 907 (Fed. Cir. 1985). Thus, even if the prior art's teachings about controlling the engine and the motor are not the centerpiece of their disclosures, *e.g.*, the teachings about selecting the appropriate gear or transmission being more prominent, that does not

help the position of the Patent Owner. Patent Owner acknowledges that the claims do not exclude the presence of a transmission control system. PO Resp. 29.

Second, Patent Owner again argues that the sub-optimal control algorithm of Bumby II and Bumby III compares "*demand power*" to a defined range of demand powers "to determine whether or not to use the engine to propel the vehicle," rather than compares road load against a setpoint or predetermined torque value. PO Resp. 30. According to Patent Owner, the two methods are fundamentally different. *Id.* at 32. We disagree. As explained above, although the sub-optimal control algorithm begins with calculating demand power, that demand power is then converted to a specific selected torque value which is compared against a setpoint. That is not fundamentally different from what is claimed. Also, with regard to the fact that speed also plays a role in the sub-optimal control algorithm of Bumby II and Bumby III, we have explained above that the claims do not exclude the additional comparison of other parameters in the control process.

c) That Bumby IV and Bumby V Teach Away from Bumby II and Bumby III

Patent Owner argues that Bumby IV and Bumby V teach away from the disclosures of Bumby II and Bumby III. PO Resp. 39–42. The argument is unpersuasive.

First, Patent Owner asserts that "Bumby IV discloses no control algorithm at all." *Id.* at 39. But the control algorithm is described in Bumby II and Bumby III. We have determined above that the disclosures of each of Bumby II, Bumby III, and Bumby IV have been adopted for use in Bumby

V. Thus, it is unnecessary for either Bumby IV or Bumby V to reiterate what is already described in Bumby II and Bumby III. Moreover, the lack of disclosure on a subject does not constitute an affirmative "teaching away" on a subject.

Second, Patent Owner notes that Bumby V discloses a "test rig" that uses vehicle speed to determine the operational mode, and argues that a speed-based controller is used in Bumby V to decide when to switch between all electric, all internal combustion engine, and hybrid modes of operation. *Id.* Patent Owner further asserts that Bumby V is silent on why it uses vehicle speed as the parameter for its control strategy. *Id.* at 39–40. Bumby V does disclose a test rig that uses vehicle speed to determine the vehicle's operational mode, but Patent Owner's reliance on that fact as a teaching away from using the sub-optimal control algorithm of Bumby II and III is both unpersuasive and misplaced.

As is noted by Petitioner (Reply 13), Bumby V explains that the testing described therein is performed using an "arbitrary speed-based mode controller" that is "intended purely to demonstrate" that the control system illustrated by Bumby V's Figure 16 "is capable of following the dictates of any more sophisticated control strategy such as those described in [Bumby II]." Ex. 1909, 19. Also as is noted by Petitioner (Reply 13), like Bumby II and Bumby III, Bumby V pertains to providing a "torque control system." Ex. 1909, 2 ("Torque control systems for the internal-combustion engine and the electric-traction motor are designed using digital transfer functions and indirect methods of torque measurement."). Further as noted

by Petitioner (Reply 13), Bumby V states: "The job of the P+I speed controller is to map varying speed demands to appropriate torque demands." Ex. 1909, 15. Such evidence simply does not support Patent Owner's contention that Bumby V teaches away from using torque as a parameter for determining the operational mode of a hybrid vehicle.

Third, Patent Owner points out that in Masding it is described that a fundamental problem with the sub-optimal control strategy of Bumby II and Bumby III is an "excessive number[] of gear shifts." PO Resp. 40. Patent Owner further notes that in Masding it is indicated that because of the excessive gear shifting problems of Bumby II and Bumby III, implementation of the Bumby II and Bumby III control algorithm "would probably lead to unacceptable driveability on the road." *Id.* at 40. These arguments do not establish any "teaching away" in Bumby IV or Bumby V with regard to the disclosures of Bumby II and Bumby III. Masding is a prior art reference on its own, separate and apart from Bumby IV and from Bumby V. Furthermore, as is noted by Petitioner (Reply 23), Masding does not convey that the issues it noted cannot be solved. We credit the testimony and explanation of Dr. Davis (Ex. 1951 ¶¶ 37–38) that Masding does not teach that the sub-optimal control algorithm of Bumby II and Bumby III is inoperable. For instance, Dr. Davis points out that Masding discusses that steps were being taken to correct the noted problems, and Dr. Davis states: "Simply because the engineers working on the hybrid vehicle uncovered a problem and worked to solve it does not teach the system as a whole is inoperable. This is simply part of the routine development process."

Ex. 1951 ¶ 38.

Fourth, Patent Owner argues that the sub-optimal control algorithm of Bumby II and Bumby III "actually results in a hybrid car with *worse* fuel consumption than a conventional non-hybrid car." PO Resp. 41. Patent Owner asserts:

> The final two columns in Table 3a and 3b of Bumby II show "two suitably weighted average fuel-consumption figures to give an indication of the overall fuel economy." *See* Ex. 1906 at 12; Ex. 2904 at ¶¶ 94-97. "The suboptimal control strategy is assumed in producing the hybrid results"—those hybrid results show fuel consumption rates *worse* than a conventional vehicle.

Id. The argument is unpersuasive, as it is overly broad. The two tables referenced by Patent Owner compare fuel consumption of the hybrid vehicle with a conventional vehicle, but with each vehicle in multiple configurations. With the base configuration, the hybrid vehicle has better fuel economy. Petitioner correctly indicates that Patent Owner ignore that data. Reply 24. Bumby II describes that each line in these tables following the first line corresponding the base configuration of vehicles reflect the results of adding progressive improvements to the vehicle's power train. Ex. 1906, 12. Thus, even a conventional vehicle using only an internal combustion engine can be improved in its fuel efficiency by undertaking certain measures. That a conventional vehicle, if modified from its basic configuration to improve fuel efficiency, can equal or better the fuel efficiency of a hybrid vehicle using the sub-optimal control algorithm of Bumby II, does not establish, categorically, that the sub-optimal control algorithm results in worse fuel efficiency than a conventional vehicle.

Patent Owner's argument reflects an over-simplification of the issue. Furthermore, what the tables show in Bumby II do not translate to a "teaching away" in Bumby IV and V from using the sub-optimal control algorithm of Bumby II and Bumby III.

III. CONCLUSION[7]

Petitioner has shown, by a preponderance of the evidence, that claims 172, 226, 230, and 234 are unpatentable as obvious over Bumby I, Bumby II, Bumby III, Bumby IV, Bumby V, and Masding.

IV. ORDER

It is

ORDERED that this *inter partes* review, with respect to claims 161 and 215, is *dismissed*;

FURTHER ORDERED that claims 172, 226, 230, and 234 of the '634 patent are unpatentable; and

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

[7] In making these obviousness conclusions, we recognize that it is the subject matter of each claim, as a whole, that is evaluated, rather than just each individual limitation, separately. 35 U.S.C. § 103.

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