

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NATIONAL OILWELL VARCO, L.P.,
Petitioner,

v.

TECHNICAL INDUSTRIES, INC.,
Patent Owner.

Case IPR2017-00910
Patent 7,997,138 B2

Before THOMAS L. GIANNETTI, BRYAN F. MOORE, and
JASON J. CHUNG, *Administrative Patent Judges*.

GIANNETTI, *Administrative Patent Judge*.

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

I. INTRODUCTION

National Oilwell Varco, L.P. (“Petitioner”) filed a Petition requesting *inter partes* review of claims 1–21 (all claims) of U.S. Patent No. 7,997,138 B2 (Ex. 1001, “the ’138 patent”). Paper 1 (“Pet.”). Technical Industries, Inc. (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). Applying the standard set forth in 35 U.S.C. § 314(a), which requires demonstration of a reasonable likelihood that Petitioner would prevail with respect to at least one challenged claim, we granted Petitioner’s request and instituted an *inter partes* review on all those remaining challenged claims. Paper 14 (“Institution Dec.”).

Following institution, Patent Owner filed a Response to the Petition (Paper 18, “PO Resp.”) and Petitioner filed a Reply (Paper 26, “Pet. Reply”).

An Oral Hearing in this case was held on May 17, 2018.¹ The Hearing Transcript (“Tr.”) is included in the record as Paper 38.

Having considered the evidence of record, and for the reasons set forth below, we determine that all claims (claims 1–21) of the ’138 patent are unpatentable.

II. BACKGROUND

A. *Related Matters*

The parties advise us that the ’138 patent is asserted in *Technical Industries, Inc. v. National Oilwell Varco, L.P.*, Case No. 6:15-cv-02744

¹ The case was heard jointly with IPR2017-00860, involving the same parties and related patent 7,552,640.

(W.D. La.). Pet. 3; Paper 4, 2. In addition, Petitioner has challenged three patents related to the '640 patent in IPR2017-00648, IPR2017-00699, and IPR2017-00860. Paper 4, 2.

B. The '138 Patent

The '138 patent is titled “Method for Inspection of Metal Tubular Goods.” The patent relates to the non-destructive testing of tubular metal goods (i.e., pipes). Ex. 1001, 1:22–23. More particularly, the patent relates to a non-destructive means for determination of wall conditions, particularly wall thickness data, of tubular metal goods by use of ultrasonic detection apparatus. *Id.* at 1:23–27.

The '138 patent acknowledges that the use of ultrasonic technology to inspect a metal tubular by determining wall thickness at a position on the tubular was known in the art prior to the time of invention. *Id.* at 2:42–3:6. The patent thus relates to improved methods to acquire, collect, assemble, store, display, and utilize such data, not only for a determination for the presence or absence of defects, but also so that data from the inspection may be used to calculate projected performance of the tubular. *Id.* at 3:7–12. The '138 patent explains that “data contained in digital format which represents wall thickness or each incremental section of a tubular and the location of that section can be used in computations which predict the actual effect on the tubular to various stressors, including tensile, bending, collapse and burst forces, aging, etc.” *Id.* at 9:6–11.

The '138 patent discloses the use of ultrasonic technology to acquire incremental data representing small, discrete sections of the tubular wall, in association with three-dimensional positional data pertaining to each small,

discrete section. *Id.* at 1:31–35. In this way, the wall of a metal tubular (or portions thereof) can be displayed, imaged, examined, and used in simulative or comparative programs as a three-dimensional object. *Id.* at 1:35–38.

According to the '138 patent, the prior art provided two-dimensional data and did not meet the need to improve the inspection of metal tubulars. The patent explains that while the prior art was able to measure wall thickness, circumferential position, and longitudinal position,

[t]ypically the data resulting from such testing [from the prior art] is displayed in two-dimensional form, as a numeric table or as a line on a graph (representing wall thickness at a position on the length of the tubular).

Ex. 1001 at 2:59–62. Still referring to the prior art, the '138 patent states: “From such data the general location of a suspected defect along the length of tubular, its magnitude and direction (whether too thin or too thick) can be determined and the tubular joint marked for acceptance, rejection or repair.”

Id. at 2:65-3:2. The patent goes on to state:

[S]aid data was not useful for substantial purposes therebeyond. Namely, without three-dimensional data as to both the defect and the remainder of the tubular, the effect that defect might have concerning performance of the tubular could not be calculated with mathematical precision.

Id. at 3:2–3:6.

The '138 patent provides no further details about how use of a “three-dimensional form” provides additional “mathematical precision,” through a mathematics formula, picture, computer program, or any other means.

C. Illustrative Claim

Claim 1 is the only independent claim. Each of the challenged claims, therefore, depends, directly or indirectly, from claim 1, which is reproduced below.

1. Method for predicting performance of tubular goods, comprising:
 - a. positioning an ultrasonic detection means which is capable of measuring the thickness of a discrete section of the wall of a tubular good in a plurality of adjacent, partially overlapping sampling positions spaced longitudinally and circumferentially along an area to be inspected of the wall of a tubular good;
 - b. at each sampling position, causing said ultrasonic detection means to determine the thickness of a discrete portion of the wall of said tubular good;
 - c. for each sampling position, determining the longitudinal position of said ultrasonic detection means along the axis of said tubular good and the circumferential position of said ultrasonic detection means about the circumference of said tubular good;
 - d. recording the measurements of wall thickness in an associated relationship with their corresponding longitudinal positions and circumferential positions to form a computer-readable, three dimensional representation of the wall of the tubular good over the area to be inspected; and
 - e. using the three-dimensional representation in computations to predict the effect of specific stress conditions on the tubular good.

III. ANALYSIS

A. Prior Art and Other Evidence Relied Upon

Petitioner relies upon the following references (Pet. 5–6):

Kiefer	US 5,641,909	June 24, 1997	(Ex. 1003)
Lam	US 2003/0033880 A1	Feb. 20, 2003	(Ex. 1004)
Palusamy	US 4,935,195	June 19, 1990	(Ex. 1031)

Assanelli, et al., *Collapse Behavior of Casings: Measurement Techniques, Numerical Analyses and Full Scale Testing*, 1998 SPE/ATW Risk Based Design of Well Casing and Tubing Conference (1998) (Ex. 1005).

Both sides also rely on expert testimony. Petitioner presents a Declaration of John P. Rodgers, Ph.D. (“Rodgers Decl.” Ex. 1007) and Supplemental Declaration of Dr. Rodgers (“Rodgers Supp. Decl.” Ex. 1034). Patent Owner relies on Declarations of William J. Emblom, Ph.D. (“Emblom Decl.” Ex. 2007), C. Mike Webre (“Webre Decl.” Ex. 2008), and George M. Sfier (“Sfier Decl.” Ex. 2009). The record also includes deposition transcripts for each of these witnesses.²

B. The Asserted Grounds of Unpatentability

We instituted *inter partes* review of the claims on two separate grounds. For two additional grounds, however, we determined that Petitioner had not established a reasonable likelihood of prevailing. Institution Dec. 23 (obviousness of claims 1–21 over Assanelli and Lam);

² Ex. 2010 (“Rodgers Dep.”), Ex. 2012 (“Rodgers Supp. Dep.”), Ex. 2013 (“Emblom Dep.”), Ex. 2014 (“Webre Dep.”), and Ex. 2015 (“Sfir Dep.”).

and 25 (obviousness of claims 8, 9, 14, 15, 20 and 21 over Assanelli, Lam and Palusamy).

On April 24, 2018, the Supreme Court held that a final written decision under 35 U.S.C. § 318(a) must decide the patentability of all claims challenged in the petition. *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018). On April 27, 2018, we modified our Institution Decision to include all grounds presented in the Petition. Paper 36.

At the Oral Hearing, the parties agreed to limit the trial to the grounds for which trial was instituted originally. Tr. 5:3–6:2. Thus, the following challenges remain for decision:

Claim(s)	Basis	References
1–21	§ 103(a)	Kiefer and Assanelli
8, 9, 14, 15, 20 ³ , 21	§ 103(a)	Kiefer, Assanelli, and Palusamy

Paper 39, 4.

C. Claim Construction

In an *inter partes* review, the Board interprets claim terms in an unexpired patent according to the 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 (2016). Under that standard, and absent any special definitions, we give

³ Claim 20 was inadvertently omitted from the summary in our Institution Decision. Paper 14, 3.

claim terms their ordinary and customary meaning, as would be understood by one of ordinary skill in the art at the time of the invention. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Additionally, any special definitions for claim terms must be set forth with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In our Institution Decision, we construed the following terms.

1. “*partially overlapping sampling positions*”

This term appears in claim element 1a as follows:

positioning an ultrasonic detection means which is capable of measuring the thickness of a discrete section of the wall of a tubular good in a plurality of adjacent, *partially overlapping sampling positions* spaced longitudinally and circumferentially along an area to be inspected of the wall of a tubular good.

Ex. 1001, claim 1 (emphasis added).

The specification of the ’138 patent does not provide a special definition for this term. The dictionary definition of overlap is: “extend over and cover a part of.” *The Random House College Dictionary* 948 (rev. ed. 1982). Taking into account the common meaning of “overlap,” we construed this term as requiring positioning the detection means such that each measurement of wall thickness extends over and covers part of an adjacent discrete portion. Institution Dec. 7. Neither party has challenged this construction. Thus, for the reasons discussed in our Institution Decision, we construe “*partially overlapping sampling positions*” as requiring each measurement of wall thickness to extend over and cover part of an adjacent discrete portion.

2. “*effect of specific stress conditions*”

This term appears in claim element 1e as follows: “using the three-dimensional representation in computations to predict the effect of specific stress conditions on the tubular good.” Petitioner proposed the following construction: “This should be construed as using the three-dimensional representation to show defects caused by stress applied to the tubular.” Pet. 12. Patent Owner opposed, arguing that claim 1 “is directed to making a *predictive*, mathematically precise, *computation* as to performance of tubular goods, namely what stresses they will be able to withstand without failing.” Prelim. Resp. 19.

We generally agreed that Petitioner’s proposed construction was incomplete. According to claim 1e, the purpose of the computation is to “predict the effect of specific stress conditions on the tubular goods.” Ex. 1001, claim 1e; Prelim. Resp.19. We, therefore, determined that this term, properly construed, requires the three-dimensional representation be used to predict effects caused by stress to the tubular. Institution Dec. 7–8. Neither party challenges this interpretation. Thus, for the reasons stated in our Institution Decision, we adopt that construction for this Decision.

Patent Owner’s Response urges: “Claim 1 is directed to making a *predictive*, mathematically precise, *computation* as to performance of tubular goods, namely what stresses they will be able to withstand without failing (or looked at another way, under what stress conditions they will fail), whether they are defective or not, and not merely making a visual display (‘show’ defects ‘caused by’).” PO Resp. 13. Patent Owner does not provide

any supporting citations for this further suggestion. We do not adopt this statement, inasmuch as it imposes additional conditions (e.g., “mathematically precise”) that are not supported by the intrinsic or extrinsic record.

3. *“for use in oil and gas exploration and production”*

This term appears in dependent claims 9, 15, and 21. Petitioner proposed the following: “This should be construed as conducting the inspection on a tubular good that could potentially be used during oil and gas exploration or production.” Pet. 16. Patent Owner did not comment on this construction and this claim element does not appear to be in dispute. We therefore do not address this construction further.

4. *Other terms*

Patent Owner asks us to construe the terms “computer-readable” and “computations” in claim elements 1d and 1e as requiring “a computer device that is capable of and is used to perform mathematical calculations from properly formatted data input to it.” PO Resp. 13. Patent Owner does not provide any supporting citations for this construction.

We are not persuaded to adopt Patent Owner’s construction. The claim itself sets forth what the claimed computer device is being used for; thus, no further explanation is necessary. Moreover, Patent Owner’s construction of “computer” is too restrictive in describing what a digital computer is capable of and does. Under Patent Owner’s construction, a computer is required to perform “mathematical calculations.” A broader application of the term is reflected by the *Microsoft Computer Dictionary*,

which defines it as “[a]ny device capable of processing information to produce a desired result.” *Microsoft Computer Dictionary* (5th edition) 118. We, therefore, are not persuaded to accept Patent Owners’ limitation of computers to devices performing “mathematical calculations” as reflecting the plain and ordinary meaning of the term.

In view of our analysis, we determine that no additional claim terms require construction at this stage. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (Only terms which are in controversy need to be construed, and only to the extent necessary to resolve the controversy).

D. Obviousness

A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007).

The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and, (4) where in evidence, so-called secondary considerations, including commercial success, long-felt but unsolved needs, failure of others, and unexpected results. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966) (“the *Graham* factors”).

E. Level of Ordinary Skill in the Art

The level of skill in the art is a factual determination that provides a primary guarantee of objectivity in an obviousness analysis. *Al-Site Corp. v. VSI Int'l Inc.*, 174 F.3d 1308, 1324 (Fed. Cir. 1999) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991)).

In defining the person of ordinary skill, an important consideration is the purpose of the patent. Thus, in *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356 (Fed. Cir. 2006), where the patent was directed to an improved process for dyeing textile materials with indigo, the Federal Circuit rejected an argument that the person of ordinary skill was a dyer. 464 F.3d at 1362. Reversing a jury verdict of infringement, the Court observed:

Designing an optimal dyeing process requires knowledge of chemistry and systems engineering, for example, and by no means can be undertaken by a person of only high school education whose skill set is limited to “flipping the switches”.

Id. To the same effect is *In re Grout*, 377 F.2d 1019 (C.C.P.A. 1967), where the patent sought by the appellant related to honeycomb supporting features for beehives. 377 F.2d at 1022. Rejecting the appellant’s contention that persons of ordinary skill were beekeepers, the Court focused on the problem addressed by the invention:

[W]e are not convinced that the ‘person having ordinary skill in the art to which said subject matter pertains,’ section 103, is exemplified by a beekeeper. Appellant’s invention relates to novel fastening means used in beehives. It is alleged that a problem existed in the support of honeycomb foundations which appellant solved. While this problem would be encountered by

a beekeeper, we think the problem naturally calls for the talents of one skilled in the art of fasteners.

Id. See also Jonathan J. Darrow, *The Neglected Dimension of Patent Law's PHOSITA Standard*, 25 Harv. J.L. & Tech 227, 238 (2009) (“Case law has established that using a product . . . is not the appropriate conception of the [person of ordinary skill]’s art.”).

The ’138 patent claims the benefit of a provisional application filed in 2003. Ex. 1001 [60].⁴ Petitioner asserts that a person of ordinary skill in the art in 2003 “would have had at least a Bachelor of Science degree in mechanical, petroleum, or chemical engineering and at least 2–3 years of experience with pipe testing technology.” Pet. 6. According to Petitioner’s expert, Dr. Rodgers, a person of ordinary skill “would have easily recognized that digital data representing a tubular wall can be used to create a three-dimensional figure of the tubular wall and to determine the effect of stresses on the tubular wall.” Rodgers Decl. ¶ 23. Moreover, Dr. Rodgers testifies:

A [person of ordinary skill] would have been familiar with common programs used in the engineering field, such as Microsoft Excel, MATLAB, and AutoCAD. Using multiple data points with three measured components (x, y, or z) to create a three-dimensional object with these types of programs would have been well within the knowledge and capabilities of a [person of ordinary skill].

Id.

⁴ We express no opinion as to whether this claim entitles the ’138 patent to the filing date of the provisional application.

Patent Owner responds that Petitioner’s definition “substantially overstates the qualifications of a [person of ordinary skill] in the field of pipe testing.” PO Resp. 35. Relying on testimony from its expert on pipe testing, Mr. Webre, Patent Owner argues that a person of ordinary skill in 2003 “would be a person that was exposed to tubular inspection methods and equipment that was in commercial use by providers of tubular inspection services or as a user of pipe inspection services.” *Id.* at 36. Further relying on Mr. Webre, Patent Owner contends such a person “would not necessarily have had a college degree, let alone an undergraduate degree in engineering or other similar technical field.” *Id.*

According to Patent Owner, Mr. Webre’s testimony “refutes that a [person of ordinary skill] in 2003 – especially a non-engineer – would be capable of developing the computational algorithms that would be required to correlate the dimensional output of a full body tubular inspection to the actual anticipated failure load capacity as required by the claims at issue in this matter.” *Id.* Patent Owner relies also on testimony to the same effect from Mr. Sfier, a named inventor of the ’138 patent. *Id.* at 36–37.

We are not persuaded that Patent Owner definition of the person of ordinary skill is consistent with the Federal Circuit’s guidance. Patent Owner focuses on the person who operates the pipe inspection equipment, and not the person who designs and builds the equipment. *See*, for example, Mr. Sfier’s testimony on cross-examination:

Q: So the person you're describing -- again, I'm talking about a hypothetical person that doesn't have a college degree but has six or seven years in the industry operating these ultrasonic machines to inspect pipe. That person, to make or use the

invention would need help, would need someone who knows how to do the computer programming?

....

[Mr. Sfier]: Yes.

Tr. 41:16–42:1. To the same effect is the direct testimony of Mr. Webre: “Over the span [sic.] of my career I have worked with and interfaced with many individuals in the inspection industry including many who were focused on *pipe inspection* that I would consider to be POSITAs.” Webre Decl. ¶ 17 (emphasis added). Mr. Webre’s testimony elaborates on this statement with a discussion of the “recognized industry standard” for certification of nondestructive pipe testing personnel. *Id.* at ¶ 18.

We find the testimony of Dr. Rodgers on the person of ordinary skill more consistent with the Federal Circuit’s guidance on that subject. Rodgers Decl. ¶¶ 15–25. Similar to the beekeeper case, *In re Grout*, discussed *supra*, Dr. Rodgers’ analysis of the person of ordinary skill focuses on the problems addressed by the ’138 patent. He testifies that the person of ordinary skill “would have recognized that there were many commercially-available programs at the time of the earliest priority date of the ’138 patent, which could have been used to create a three-dimensional model with pipe inspection data.” *Id.* at ¶ 18. This testimony is credible because it is consistent with the ’138 patent, which describes the use of commercially available “simulative/comparative programs” to create three-dimensional objects. Ex. 1001, 1:31–38.

We also find credible Dr. Rodgers’ testimony that there were “many commercially-available programs that could conduct a stress analysis to determine the effect of stressors on the tubular wall using this three-

dimensional model created from pipe inspection data.” Rodgers Decl. ¶ 19. This testimony, too, is consistent with the ’138 patent, which indicates such programs were known. Ex. 1001, 3:33–41. As Dr. Rodgers points out, the ’138 patent provides no further description of such programs, a recognition that they were well known and available. Rodgers Decl. ¶ 19.

We are not persuaded by Patent Owner’s criticism of Dr. Rodgers’ testimony for his lack of experience in pipe inspection. See PO Resp. 37–39. We are satisfied with Dr. Rodgers’ qualifications to testify as an expert, including his experience in the oil industry developing new mechanical tools and software tools focused on measuring and analyzing the dynamic response of downhole tools and systems (including tubulars used in drilling, perforating, testing, and producing wells) and also his analysis of oilfield tubulars for static and dynamic loading. Rodgers Decl. ¶ 9.⁵ Patent Owner’s criticism of Dr. Rodgers’ qualifications because he is qualified insufficiently “in the field of pipe inspection” reflects Patent Owner’s argument (which we reject) that the person of ordinary skill is a pipe inspector. As discussed *supra*, we are not persuaded that a pipe inspector would be called upon to solve the problem identified by the ’138 patent. Finally, Patent Owner asserts:

Rodgers does not identify a single POSITA who, in 2003, was using, was working on using, or had even conceived of using data, collected by ultra-sonic means, which was stored in

⁵ Dr. Rodgers has a Ph.D. from MIT and did graduate research on the application of ultrasonic transducers. Rodgers Decl. ¶ 8. Moreover, he has over 15 years of experience as an engineering consultant, mostly in the oil industry. *Id.* at ¶ 9.

computer readable format to manually or by computer to calculate strength of pipe proposed to be used in a particular application. Simply put, Dr. Rodgers [is] not a POSITA in the 2003 field of pipe inspection.

PO Resp. 39. We are not persuaded by this argument. First, it repeats an argument that we have rejected, namely, that pipe inspectors are the relevant persons of skill. Moreover, it overlooks the fact that the person of ordinary skill is a “theoretical construct,” and is “not descriptive of some particular individual.” *Norgren Inc. v. Intl. Trade Com’n*, 699 F.3d 1317, 1325 (Fed Cir. 2012). Finally, it ignores the ’138 patent’s description of the prior art as including collecting and storing ultrasonic pipe thickness data and using it to calculate stressors. *See supra*.

For the foregoing reasons, we adopt Petitioner’s definition of the person of ordinary skill and credit Dr. Rodgers’ testimony as to what that hypothetical person would have known at the 2003 filing date of the ’138 patent.

*F. Obviousness of Claims 1–21
Over Kiefer and Assanelli*

Petitioner contends that claims 1–21 would have been obvious over Kiefer and Assanelli combined. Pet. 16–21. Petitioner contends that each element of those claims is found in the references together. *Id.* at 21–39.

1. Introduction

At the outset of our analysis, we refer to Patent Owner’s explanation of the “problems solved” by the ’138 patent. PO Resp. 7–11. In describing the state of the art before the alleged invention, Patent Owner refers to the

existing techniques for using ultrasonics for measuring wall thickness of pipe. *Id.* at 7–8. According to Patent Owner,

[d]ue to the sheer volume of data generated by this testing approach, prior art ultrasonic measurements were typically only taken at a relatively small number of positions along the area of a tubular. Such low-density sampling of pipe resulted in significant parts of a tubular member going unmeasured.”

Id. at 8.

Patent Owner goes on to explain that “even when a relatively large number of measurements were taken, much of the data had to be discarded because *the means to store and process such large amounts of data had not yet been developed.*” *Id.* (emphasis added). We note that this argument is consistent with the specification of the ’138 patent, which describes the patent as directed to “an improved method of collecting, storing, displaying and otherwise utilizing the information resulting from ultrasonic detection of the walls of metal tubulars.” Ex. 1001, 1:28–31.

Patent Owner acknowledges that the finite element method, a technique for analyzing stress, “is a mathematical tool that was developed well before computers were designed and/or programmed to implement the tool.” PO Resp. 41. Patent Owner’s alleged contribution thus lies in the application of computers to perform stress calculations that previously were impractical:

Patent Owner, for the first time, taught the use of intense ultrasonic data recorded in format specifically designed to be readable by digital computer and using a digital computer to calculate with mathematical precision - the actual strength of a particular joint of pipe.

PO Resp. 8.

2. *Kiefer* (Ex. 1003)

Kiefer is a patent titled “Scan Assembly Structure.” *Kiefer* is directed to apparatus for inspecting buried natural gas mains. Ex. 1003, 1:4–7. It describes apparatus that “provides one hundred percent inspection of the walls of gas mains under operating flow conditions through the use of a unique scanning unit which is inserted into working gas mains to collect [data] for production of graphic images of the wall forming the gas main.” *Id.* at 1:46–51.

Kiefer teaches that the inspection apparatus “contains an ultrasonic transducer which directs an interrogating pulse into the wall of the gas main at a pre-determined angularly spaced-apart interval” such that “[t]he interrogating pulses form a helical scan pattern.” *Id.* at 2:1–4. *Kiefer* further explains:

The return pulses (reflective pulses) from the surfaces defining the inner diameter and outer diameter of the gas main and any imperfections or flaws within the wall of the main are received by the transducer, converted into digital form, and are subsequently transmitted to a surface unit which produces a tomograph of the wall of the gas main. In essence, a model of the condition of the surfaces defining the inner diameter and outer diameter of the gas main and a cross-sectional view of the wall of the gas main is generated over the length of the main.

Id. at 2:4–14.

This is shown in Figure 8 of *Kiefer*, reproduced below.

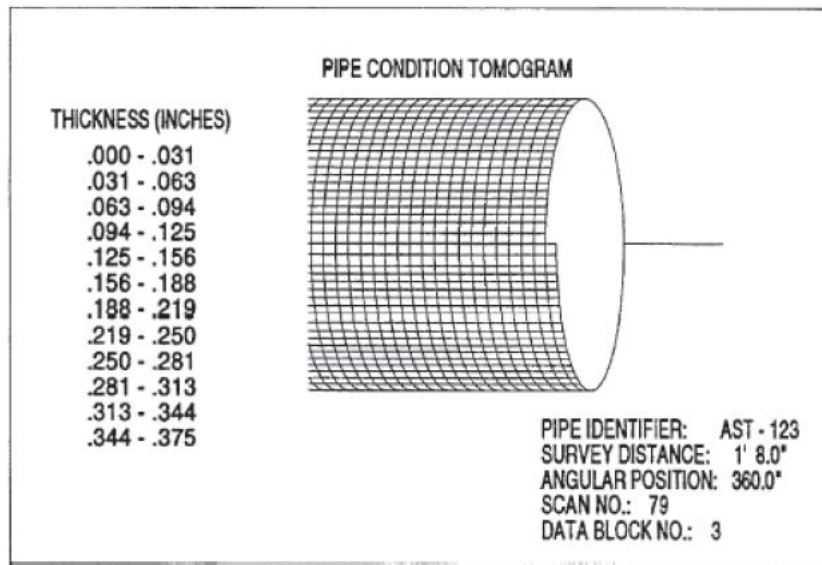


FIG. 8

Figure 8 is a tomograph of a gas main produced by the scan unit assembly of Kiefer. Kiefer explains that “[f]rom such a tomographic image, the surfaces defining the inner and outer diameters of the wall of the gas main and any imperfections or flaws within the wall of the gas main can be examined and accurate physical dimensions of same can be determined.” *Id.* at 5:41–45.

3. Assanelli (Ex. 1005)

Assanelli is a paper disclosing the use of the finite element method and three-dimensional modeling to predict the effects of casing (i.e., tubular) geometry—including wall thickness—on the external collapse pressure for that casing. Ex. 1005, 1. Assanelli explains that wall thickness contributes to many of the factors that influence the external pressure at which a steel pipe will collapse, including: the ratio of outside pipe diameter to wall thickness; the yield stress of the pipe; the shape of pipe sections (outside diameter shape and thickness distribution); the residual stresses locked in the

pipe steel; and the localized imperfections introduced in production, handling, or due to localized wear. *Id.* at 1, 4. Assanelli also observes that it is normal for wall thickness to change along the length of a pipe. *Id.* at 1.

Assanelli describes the acquisition of geometrical information from test pipes with an “imperfection measuring system,” and the use of that information as input data for three-dimensional finite element models to predict pipe collapse pressure. *Id.* According to the paper: “The 3D model predictions have been qualified via experimental testing at our laboratory.” *Id.* Figure 1 of Assanelli follows:

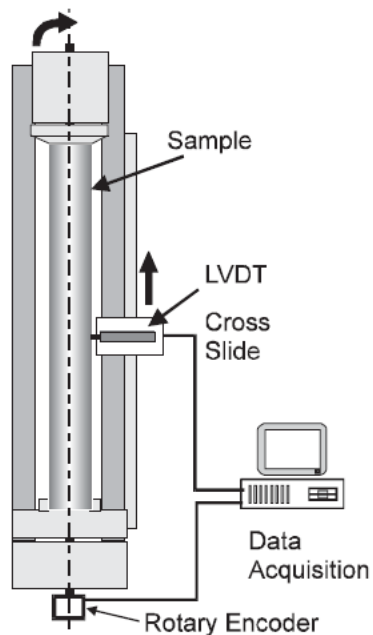


Figure 1 illustrates a test setup for mapping the external surface of a pipe sample to measure imperfections. The position of the pipe surface is measured via a Linear Variable Displacement Transducer (LVDT). A rotary encoder placed in the rotation axis provides the angular position information. Ex. 1005, 2.

Assanelli discloses the performance of “in-depth pipe outside diameter (OD) and thickness mappings,” and explains that pipe wall “thickness is measured manually at 272 locations, using an ultrasonic gauge (Fig. 5). An enhancement of the device is planned, which will allow [it] to measure the wall thickness on-line with the outside diameter.” *Id.* at 2. Assanelli further discloses that the information of the full scale test, including wall thickness measurement data, is stored in a database. *Id.*

Figure 1 also shows a “data acquisition” unit. Although not discussed in the text, Dr. Rodgers identifies this as a computer that records the data set collected from the scan of the pipe wall. Rodgers Decl. ¶ 161. Dr. Rodgers testifies that the data set “incorporates longitudinal and angular position, wall thickness, and other measurements.” *Id.*

Assanelli discloses that angular and longitudinal position information is collected and associated with pipe wall thickness measurements. This information is shown in Figure 5 of Assanelli, reproduced below.

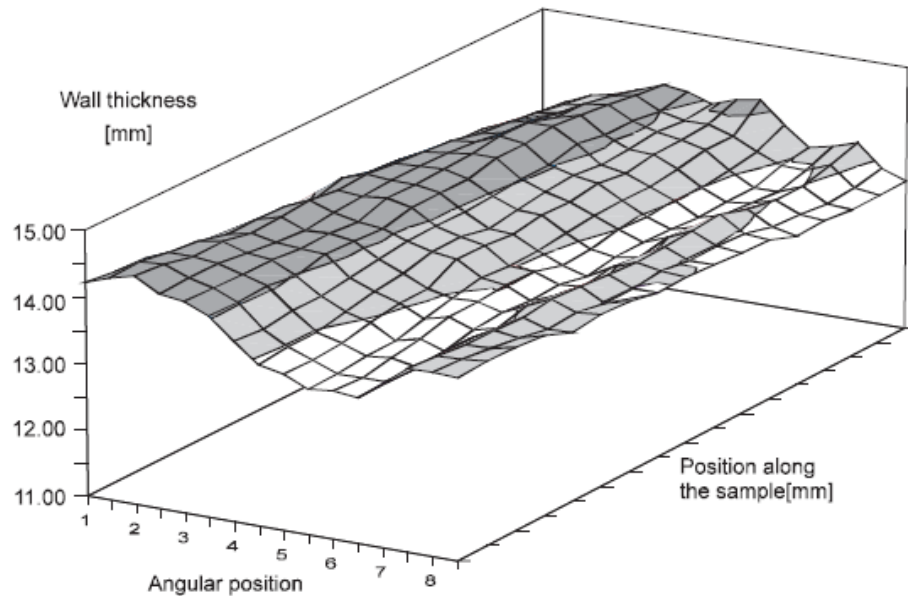


Fig. 5—Wall thickness distribution

Figure 5 plots wall thickness data for various angular and longitudinal positions on a test pipe to depict the wall thickness distribution for that pipe. Ex. 1003, Fig. 5.

Assanelli additionally teaches the use of wall thickness data from different positions on a test pipe to create a three-dimensional finite element model of that pipe. *Id.* at 3. This is shown here in Figure 8 of Assanelli:

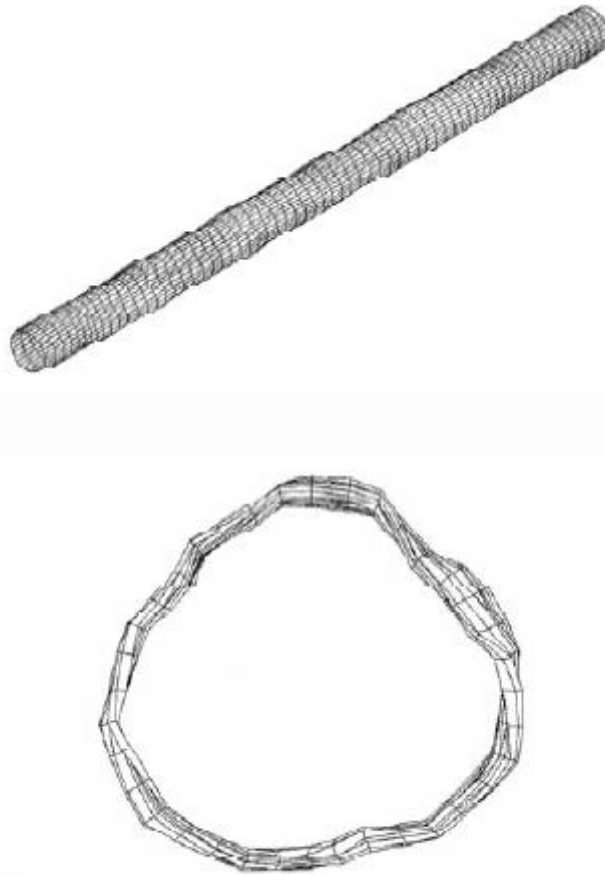


Fig. 8—Three dimensional finite element model (imperfections amplified 50 x)

Figure 8 depicts a three-dimensional finite element model showing wall thickness in lengthwise as well as cross-sectional views.

Assanelli further teaches that three-dimensional models can be used in finite element models to predict how a pipe will respond to stressors.

Figure 9 of Assanelli is reproduced below.

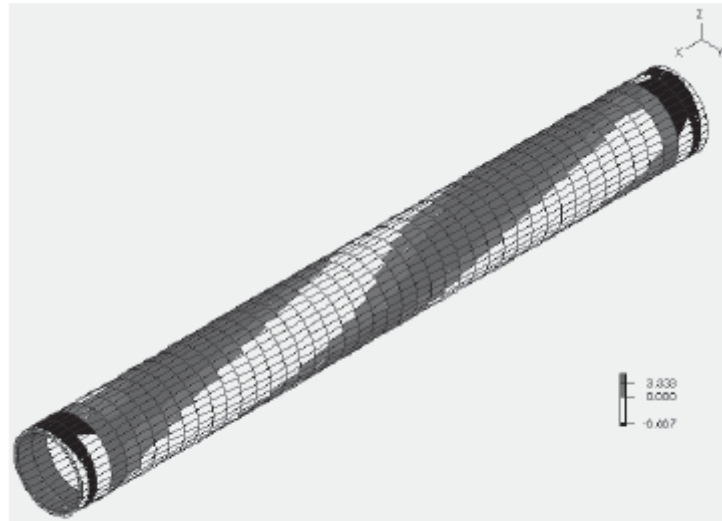


**Fig. 9—Finite element model of a pipe with helical ovality.
Distribution of axial stresses at the external surface**

Figure 9 depicts a three-dimensional finite element model of a pipe, and “shows the distribution of axial stresses (on the external surface) at impending collapse.” *Id.* at 3. The experts on both sides agree that the results shown in Assanelli’s Figures 8 and 9 are computer-generated. Rodgers Dep. 81:10–16, 91:20–25; Emblom Dep. 64:14–17; Webre Dep. 49:5–9.

4. Analysis

Petitioner contends that each element of claims 1–21 of the ’138 patent is found in Kiefer and Assanelli together, and provides an element-by-element analysis, including charts showing where each claim element is found in the combination. Pet. 21–29. Petitioner also provides supporting testimony from its expert, Dr. Rodgers. Rodgers Decl. ¶¶ 109–174.

For example, in support of its contention that the Kiefer/Assanelli combination discloses claim element 1a, calling for overlapping sampling, Petitioner asserts: “Kiefer discloses positioning an ultrasonic detection means, which is capable of measuring wall thickness, in a plurality of adjacent and partially overlapping sampling positions spaced apart longitudinally and circumferentially.” Pet. 21. In support of its contention that the combination discloses element 1e, calling for predicting the effect of stress conditions, Petitioner asserts: “Assanelli discloses using the three-dimensional representation in computations to predict the effect of specific stress conditions on the tubular wall.” *Id.* at 23.

Petitioner also provides claim charts for each of the dependent claims. For example, for claim 2, which specifies “at least one of” certain stress conditions, Petitioner’s chart states: “Assanelli further discloses determining the stress conditions consisting of “collapse” and “bending” forces, as well as the other forces described in this claim.” *Id.* at 23.

Patent Owner responds mainly to Petitioner’s contentions regarding claim 1, and does not argue separately the dependent claims. Patent Owner’s response initially argues that “the ’138 claims are not *anticipated* by Assanelli.” PO Resp. 14–25 (emphasis added). While it is not clear why Patent Owner advances an argument referring to anticipation in response to an obviousness challenge based upon the combination of Kiefer and Assanelli, it is clear that Patent Owner’s opposition is focused mainly on claim element 1e. This is confirmed by the fact that for claim 1, Patent Owner’s only reliance on Assanelli is to meet element 1e. Pet. 23. We will, therefore, address both Petitioner’s and Patent Owner’s arguments

concerning Assanelli in this context, as they are pertinent to whether Assanelli meets this limitation and thus to the challenge of obviousness that Petitioner does assert.

a. Assanelli Meets Claim Element 1e

As noted *supra*, Petitioner relies on Assanelli to meet the limitation of claim 1e calling for “using the three dimensional representation in computations to predict the effect of specific stress conditions on the tubular good.” Pet. 23. Petitioner’s analysis relies on Figure 9 of Assanelli, reproduced *supra*, which discloses a three-dimensional distribution of axial stresses at the external surface of a pipe. *Id.* Petitioner also relies on the testimony of Dr. Rodgers that this analysis “simulates operation in a deepwater pipeline application in which the pressure of the water column is loading on the outside of the pipe. The three-dimensional finite element analysis predicts the resulting stress conditions in the pipe wall.” Rodgers Decl. ¶ 122. Dr. Rodgers testifies further: “Assanelli discloses using the three-dimensional representation in computations to predict the effect of specific stress conditions on the tubular good.” *Id.*

In further support of its contention that Assanelli teaches this step, Petitioner asserts that “Assanelli discloses a method for inspecting and gathering ultrasonic data on oilfield tubulars using three-dimensional models that incorporate measured variations in the tubular wall thickness.” Pet. 19. In Assanelli, an ultrasonic transducer is moved longitudinally along the tubular while the tubular is rotated 360 degrees. *Id.* This allows the transducer to obtain a complete scan of the tubular wall to gather a data set for wall thickness. *Id.* The data set incorporates longitudinal and angular

position, as well. *Id.* The data set is recorded on a computer, which is referred to as a “data acquisition” unit. *Id.* After the data is gathered, the dataset is used to generate a three-dimensional model of the tubular wall with accurately represented geometry. *Id.* at 20 (citing Figs. 8 and 9, reproduced *supra*).

Patent Owner’s rebuttal argues that Assanelli does not disclose a computer capable of computing the stressors on the wall of a tubular good. PO Resp. 16. “While Assanelli does generally describe a method by which the pressure at which a pipe would be to collapse may be calculated, it does not say the calculation is done using a digital computer.” *Id.* at 3. Specifically, Patent Owner asserts “Assinelli never uses the word ‘computer’ at any point in its disclosure.” *Id.* at 16.

Patent Owner recognizes that “in FIG. 1 of Assanelli is shown a box like structure and CRT screen which might in some respects resemble what a computer, without keyboard, mouse or other human interface device might look like.” *Id.* at 3. But Patent Owner contends the device labeled “data acquisition” in Assanelli is not a computer because “[i]t does not show any mouse, keyboard, scanner or other human interface tool typically associated with a ‘digital computer.’” *Id.* at 18. Patent Owner refers to the data acquisition device as “no more than some kind of a ‘data recorder.’” *Id.*

We are persuaded by Petitioner’s arguments and Dr. Rodgers’ testimony that this element of the claims is met by Assanelli. As discussed *supra*, the plain and ordinary meaning of a computer is not restricted to performing “mathematical calculations.” *See generally Microsoft Computer Dictionary* (5th Edition) 118. Computers perform other functions such as

managing data in a data set. It is apparent from Figure 1 of Assanelli and the accompanying text that the device shown receives, organizes, and stores digital data, and therefore would meet the plain meaning of a digital computer.⁶ We, therefore, find persuasive and agree with Dr. Rodgers' testimony that the device labeled "data acquisition" in Assanelli is a computer. Rodgers Decl. ¶ 108.

The facts that peripherals such as keyboards or printers are not shown, or that Assanelli does not use the word "computer" to describe the data acquisition device do not persuade us otherwise. See PO Resp. 16–17. We are not persuaded by Patent Owner's argument that it is significant that Assanelli's "disclosure" does not use the word "computer." PO Resp. 16.⁷ For an obviousness analysis, prior art references must be "considered together with the knowledge of one of ordinary skill in the pertinent art." *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994) (quoting *In re Samour*, 571 F.2d 559, 562 (CCPA 1978)). Moreover, "it is proper to take into account not only specific teachings of the reference but also the inferences which one

⁶ Assanelli refers to a database in which "[t]he information [for] the full scale test is stored." Ex. 1005, 2. More than 100 fields were recorder for each test. *Id.*

⁷ As Patent Owner recognizes, a footnote in Assanelli citing a reference does use the word "computer." Ex. 1005 n. 23. Several other footnotes, however, cite references from computer-related journals, e.g., note 5 (*Comput. Methods Appl. Mech. Engrg.*); note 14 (*Computational Mechanics, new trends and applications*); note 15 (*Engng.Comput.*); note 16 (*Int. J. Numer. Methods in Engng.*), note 17 (*Engng. Comput.*); note 18 (*Proc. Second International Conference on Computational Plasticity*).

skilled in the art would reasonably be expected to draw therefrom.” *In re Preda*, 401 F.2d 825, 826 (CCPA 1968). That is because an obviousness analysis “need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR*, 550 U.S. at 418; *see also In re Translogic Tech., Inc.*, 504 F.3d at 1259.

We credit Dr. Rodgers’ testimony on this issue. Dr. Rodgers’ testimony is consistent with the plain meaning of a digital computer and with the ’138 patent itself, which discloses the use of computer programs in calculating pipe stress as prior art. Ex. 1001, 1:31–38; 3:38–41; Rodgers Decl. ¶ 19 (“[A person of ordinary skill in the art] would have further recognized that there were many commercially-available programs that could conduct a stress analysis to determine the effect of stressors on the tubular wall using this three-dimensional model created from pipe inspection data.”). Moreover, Assanelli’s data acquisition device is consistent with the dictionary definition of a computer as “[a]ny device capable of processing information to produce a desired result.” *Microsoft Computer Dictionary* (5th edition) 118.

Patent Owner next questions Petitioner’s evidence that, in Assanelli, a computer is used to make calculations of pipe collapse pressure, as the claims require. PO Resp. 19–20.

It is respectfully submitted Petitioner and the Board in preliminary review went “too far” in arguing and finding that the device in FIG. 1 was a computer that was used to make calculations of pipe collapse pressure.

Id. at 20. We disagree with Patent Owner and find Petitioner's evidence on this issue is more persuasive for several reasons. First, Dr. Rodgers, Dr. Emblom, and Mr. Webre all agree that the graphs in Figures 8 and 9 of Assanelli were computer-generated. *See supra*. Figure 9 is especially pertinent, because it displays, in three dimensions, the distribution of axial stresses at the external surface of a pipe at impending collapse, calculated using a finite element model. Ex. 1005, 3, Fig. 9; Rodgers Decl. ¶ 122. We, therefore, agree with Dr. Rodgers's conclusion that a person of ordinary skill would have recognized that the stresses shown in Assanelli were calculated by a computer. Rodgers Decl. ¶ 122; Rodgers Supp. Decl. ¶ 159.

Patent Owner asserts that Assanelli's finite element stress calculation may have been performed manually: "All we know is finite element method was the mathematical tool applied to the database and by finite element analysis collapse pressure was calculated . . . either manually, by a computer or some unidentified means." PO Resp. 24. We are not persuaded by this argument. We determine, instead, that a person of ordinary skill would not have concluded that the stresses in Assanelli were calculated by hand, but that they were made by digital computer. First, the fact that the wall thickness data may have been entered into the data base manually (PO Resp. 22) does not indicate that the stress calculations using that data were done manually. The reality is that all the necessary data for the stress calculation was in the data base and available to be processed digitally. We do not find it credible that one of ordinary skill would have concluded that after storing the data in digital form, Assanelli would process it manually.

Second, Dr. Rodgers provides credible rebuttal testimony indicating that “it is impractical to do these calculations by hand.” Rodgers Supp. Decl. ¶ 159. Dr. Rodgers estimates that it would take 17 years to do Assanelli’s stress calculations manually. *Id.* He concludes that “a hand calculation was not feasible for the scale of the FEA [finite element analysis] problems being shown in Assanelli and relevant to the ‘138 patent[] in this discussion.” *Id.*

Finally, we take into account the cross-examination testimony of Dr. Emblom that ADINA software was available in 2003 to perform finite element analysis. Emblom Dep. 31:19–32:8, 53:7–10. Dr. Emblom goes even further, testifying that in his opinion, ADINA software was actually used by Assanelli to generate Figures 8, 9, and 10 of his paper. *Id.* at 64:4–17.

We do not find Patent Owner’s response to Dr. Rodgers’ testimony on this issue to be persuasive. Paper 31, 6–7. Patent Owner’s argument that there is a “disconnect” between what Dr. Rodgers and a person of ordinary skill would understand from reading Assanelli (*id.* at 7) is predicated on Patent Owner’s misunderstanding of the testimony. Whether a person of ordinary skill would have the knowledge or training actually to perform the finite element calculations is not the question. The issue is whether that person would have recognized that it was not feasible to perform them without a computer. Rodgers Supp. Decl. ¶ 159.

In addition, we are persuaded by the evidence that a person of ordinary skill “would have further recognized that there were many commercially-available programs that could conduct a stress analysis to

determine the effect of stressors on the tubular wall using this three-dimensional model created from pipe inspection data.” Rodgers Decl. ¶ 19. Such a person would have recognized that Assanelli’s stress calculations were not made laboriously by hand, but were, instead, computer-generated using data already stored digitally in the data base. In this connection, we find Dr. Emblom’s testimony that ADINA software was available in 2003 to be compelling evidence. *See supra*.

Had Patent Owner’s argument on the pertinent level of skill been focused properly on the problem solved by the ’138 patent, described *supra* as one of applying computers to an existing problem, using existing analysis techniques, there would have been little room to argue that the person of ordinary skill would not have recognized that Assanelli’s stress calculations were computer-generated.

The ’138 patent is a continuation of U.S. Patent 7,552,640 (“the ’640 patent”) that is challenged in IPR2017-00840. *See supra*. The ’138 patent has the same specification as the ’640 patent and similar claims. In discussing the level of skill pertinent to the ’640 patent, which we determine would be the same as that for the ’138 patent, Patent Owner’s expert Dr. Emblom, testified “that it would take a high level of skill to produce the information and the process to actually do the work.” Emblom Dep. 173:11–14. To create the invention of the ’640 patent “would take a lot of experience to do that, probably years in service in a number of different fields” including “finite element analysis or some other modeling method.” *Id.* at 174:19–175:3. He testified also that the level of ordinary skill would

be “minimally, a bachelor’s, probably a graduate degree, plus extensive experience with respect to the work involved.” *Id.* at 176:20–25.

We have considered Patent Owner’s secondary arguments and found them unavailing. For example, at the Oral Hearing, Patent Owner’s counsel suggested that Assinelli’s stress calculations were based on an average pipe thickness, rather than on the collected data measurements for multiple pipe segments. Tr. 44:14–18. Sensing this was a new argument, not previously briefed, the Board pressed Patent Owner’s counsel for support in the record. Tr. 46:17–47:10. We did not find adequate support for the argument in the citations Patent Owner provided. Tr. 59:10–60:5. Patent Owner cited to a different Assanelli article (Ex. 1013) that is not included in Petitioner’s challenge. *Compare* Tr. 60:3–5 (citing Ex. 1013) *with* Pet. 3 (citing Ex. 1005).

Patent Owner also provided cites to Dr. Emblom’s declaration and deposition testimony. Tr. 59:16–60:2. We have reviewed this testimony and find it does not support Patent Owner’s theory. Dr. Emblom’s cited declaration testimony asserts only that the pipe thickness data in Assanelli was “manually, by human means, entered in the data base.” Emblom Decl. p. 7. Dr. Emblom’s testimony that ADINA software existed in 2003 to perform the calculations undercuts any suggestion that a person of ordinary skill would have resorted to manual calculations after the data was entered. *See supra*. In the cited Emblom deposition testimony, on redirect by Patent Owner’s counsel, Dr. Emblom was asked a hypothetical question whether, in Assanelli, a calculation of collapse pressure using average pipe thickness would be accurate, and he responded “it would not produce good answers.

. . . It would be wrong.” Emblom Dep. 158:18–159:3. This hypothetical question on redirect fails to amount to persuasive evidence that Assanelli’s calculations used average pipe thickness. In fact, by admitting it would not produce “good answers,” Dr. Emblom’s testimony, if anything, suggests the opposite. Thus, even if we were to consider Patent Owner’s “average thickness” argument as timely raised, it would not change our decision that Assanelli meets claim element 1e.

In sum, we find that Assanelli teaches using digital data recorded as described above to compute the effect of stresses on the wall of the tubular. Further, Petitioner has demonstrated by a preponderance of the evidence that Assnelli teaches the step set forth in ’138 patent claim element 1e, “using the three-dimensional representation in computations to predict the effect of specific stress conditions on the tubular good.”⁸

b. Kiefer Discloses the Remaining Elements of Claim 1

Patent Owner discusses Kiefer at pages 27–28 of its response. For the most part, Patent Owner does not contest Petitioner’s assertion that Kiefer teaches the remaining elements of claim 1. Thus, Patent Owner agrees that Kiefer describes a method for ultrasonic inspection of underground gas mains under operating flow conditions. PO Resp. 27. Patent Owner agrees that in Kiefer, data is transmitted to a display unit in order to depict

⁸ Patent Owner argues in passing that “neither Lam nor Kiefer disclose [sic.] a computer capable of computing the effect of stressors on the wall of tubular goods.” PO Resp. 15. This argument ignores the fact that Petitioner relies on Assinelli, not Kiefer or Lam, to meet element 1e of the claim, which relates to stress computations. Pet. 23.

graphically (create a tomographic image of) the wall of the gas main. *Id.* However, Patent Owner goes on to provide two arguments distinguishing Kiefer: First, Patent owner asserts: “Kiefer says nothing about use of a computer to compute pressure at which the pipeline would be expected to collapse.” *Id.* (emphasis omitted). This argument is unavailing because Petitioner relies on Assanelli, not Kiefer, for this teaching. *See discussion supra.*

Patent Owner’s second argument is that “Kiefer also says nothing about use of a computer to store ultrasonic information representing the thickness of partially over-lapping segments of a pipe associated with positional data in a computer readable format and using data contained in that format in calculations which predict the response of a work-piece to stressors.” PO Resp. 27 (emphasis omitted). We are not persuaded by this argument, either. Patent Owner provides no further explanations or supporting citations to the record. In any event, the argument fails, for the following reasons.

Breaking the argument down, the first part relates to “use of a computer to store ultrasonic information representing the thickness of partially over-lapping segments of a pipe associated with positional data in a computer readable format.” Petitioner’s analysis of Kiefer in relation to this aspect of claim 1 relies on testimony from its expert, Dr. Rodgers. Pet. 21 (citing Rodgers Decl. ¶¶ 111–114). Dr. Rodgers cites the disclosure, in Kiefer, of taking “one or more” measurements of wall thickness “per one degree of rotation.” Rodgers Decl. ¶ 114 (quoting Ex. 1003, 6:55–60). From this, Dr. Rodgers concludes:

On the very large end (most of times tubulars will be much smaller), assuming the gas main is 8 inches, the circumference would be 25.12 inches. With 360 samples per revolution, the arc-linear spacing between measurement points would be 0.070 inch. Kiefer's disclosure of a resolution this fine (and even finer with smaller mains) would be understood by a POSITA as inherently including a disclosure of taking overlapping measurements. During this time period, it would have likely been impossible for the commercially-available ultrasonic transducer beam patterns to capture this many points without obtaining overlapping coverage.

Id. Dr. Rodgers goes on to explain that Kiefer records wall thickness, longitudinal position, and circumferential position of a tubular good in an associated relationship specifically so they can be used to create a three dimensional display of the tubular. Rodgers Decl. ¶ 119 (citing Ex. 1003, Abstract, 1:46–51; 1:65–2:14, 6:9–33; 6:56–57; 5:13–45). Dr. Rodgers further testifies that Kiefer discloses taking these measurements in digital form so they can be read by a computer. *Id.* at ¶ 120 (citing Ex. 1003, 2–3:14; 5:62–6:4). Finally, Dr. Rodgers testifies that Kiefer “uses this digital, associated data to present a virtual three-dimensional picture of the tubular wall with a computer.” *Id.* at ¶ 121 (citing Ex. 1003, Fig. 8). Petitioner's analysis relies on this testimony. Pet. 22. We are persuaded by Dr. Rodger's testimony that these elements are met by Kiefer.

The second part of Patent Owner's argument distinguishing Kiefer refers to: “using data contained in that format in calculations which predict the response of a work-piece to stressors.” PO Resp. 27. The argument is beside the point and not persuasive. Petitioner relies on Assanelli, not Kiefer, for this teaching. Pet. 23.

In sum, we find that Petitioner has demonstrated that Assanelli teaches using digital data recorded as described above to compute the effect of stresses on the wall of the tubular and Kiefer meets the remaining elements of claim 1.

c. Patent Owner's Additional Arguments

We address here various other arguments advanced by Patent Owner. Patent Owner asserts that “there is absolutely no indication whatsoever that Assanelli stores ultrasonic information representing the thickness of *partially over-lapping segments* of a pipe associated with positional data in a computer readable format.” PO Resp. 30 (emphasis added). As discussed *supra*, Petitioner relies on Kiefer, not Assanelli, to meet the “over-lapping segments” element of the claims. In any event, we are persuaded that there is sufficient proof that Assanelli as well as Kiefer stores thickness data in a computer. Assanelli specifically refers to a “full scale data base” that records wall thickness and other data. Ex. 1005, 2.

Patent Owner's argument regarding Assanelli continues: “and then utilizes such data in that format to compute the predicted effect of stressors on a section of pipe using a computer.” We discuss in detail, *supra*, how this element is met by Assanelli. We are not persuaded by Patent Owner's argument that Assanelli fails to use the stored data in computations predictive of performance of pipe in intended usage. Assanelli specifically refers to his “3D model predictions.” Ex. 1005, 1. Assanelli's goal was to improve process control procedures by determining “how different parameters affect the external collapse pressure of pipes.” *Id.*

In sum, we determine that Petitioner has demonstrated, on this record,

that each element of claim 1 of the '138 patent is found in the combination of Kiefer and Assanelli.

d. Claims 2–21

As noted, Patent Owner presents no separate arguments with respect to any of dependent claims 2–21. Thus, for this challenge, the dependent claims of the '138 patent stand or fall together. *See In re Dance*, 160 F.3d 1339, 1340 n. 2 (Fed. Cir.1998) (dependent claims not argued separately on the merits rise or fall with the independent claim to which they relate); *In re Kaslow*, 707 F.2d 1366, 1376 (Fed. Cir. 1983) (“Since the claims are not separately argued, they all stand or fall together.”).

3. Rationale for Combining Kiefer and Assanelli

Petitioner asserts that an ordinarily skilled artisan would have had reason to combine Kiefer and Assanelli, and that such a combination “would have worked.” Pet. 29–32. Petitioner sets forth several reasons that persuade us the combination would have been obvious.

First, we determine that Kiefer and Assanelli disclose interrelated teachings in the same field of endeavor. Pet. 30; Rodgers Decl. ¶ 148. Kiefer and Assanelli each discloses collecting data relating to wall thickness, circumferential position, and longitudinal position, and using that data to create a three-dimensional display of a tubular. Pet. 30; Rodgers Decl. ¶ 148. Kiefer teaches recording wall thickness and positional data “for future reference and analysis.” Pet. 30 (quoting Ex. 1003, 1:39–41). Petitioner, therefore, contends, and we are persuaded, that a relevant skilled artisan would have had reason to use the wall thickness and positional data described by Kiefer in the three-dimensional finite element model taught by

Assanelli to determine the effect of various stresses on the wall of a tubular.
Id.

Moreover, we find that Kiefer and Assanelli together would have been a combination of known methods to yield predictable results. Pet. 30–31. Specifically, using the data collected by Kiefer to conduct the analysis disclosed by Assanelli would have been nothing more than applying background knowledge and common sense. *Id.* at 30. Moreover, we find that there were software tools available (such as ADINA, discussed *supra*) that could have been used to conduct Assanelli’s stress analysis with the data gathered by Kiefer. *Id.* Dr. Rodgers provides testimony supporting this finding. Rodgers Decl. ¶¶ 149–152. These programs would have been available to a person of ordinary skill. Pet. 31 (citing Rodgers Decl. ¶ 151 and Ex. 1001, 3:28–40).

Finally, market forces would have driven the combination of Kiefer and Assanelli because, at the time of the earliest priority date of the ’138 patent, the industry wanted to use thinner walled tubulars to save money and increase efficiency, thus driving the need for tubular inspection data to conduct stress analysis. Pet. 32 (citing Rodgers Decl. ¶¶ 155–156).

Patent Owner contests this issue in its Patent Owner Response. PO Resp. 39–51. Patent Owner’s argument there (and elsewhere in its papers) is unfocused and difficult to follow, and contains few, if any, citations to evidence in the record. Without appropriate record citations, it is difficult for the Board to separate attorney argument from record evidence. Accordingly, for this failure to provide adequate supporting evidence, we have given Patent Owner’s argument on this issue limited weight.

“[U]nsworn attorney argument . . . is not evidence.” *Gemtron Corp. v. Saint-Gobain Corp.*, 572 F.3d 1371, 1380 (Fed. Cir. 2009).

Patent Owner’s response on motivation to combine largely repeats its arguments directed to alleged deficiencies in Kiefer and Assanelli, individually. Patent Owner’s main argument appears to be that “Assanelli would not teach a 2003 [person of ordinary skill] to use [a] digital [] computer to calculate collapse pressure of a pipe.” PO Resp. 41. The premise of this argument — that Assanelli does not teach the use of a computer to perform stress calculations—is discussed *supra*, in the context of Patent Owner’s discussion of “anticipation” by Assanelli. We disagree with this premise for the reasons previously stated. In any event, because it is directed to one reference and not the combination, it is not a persuasive argument as to whether Assanelli and Kiefer would have been combined.

Patent Owner’s other arguments are no more persuasive. For example, Patent Owner argues that “Assanelli was directed to determining the suitability of heavy walled pipe” while “Kiefer was intended to detect corrosion . . . of low pressure, relatively thin-walled pipe.” *Id.* at 46. But there is no citation either to a reference or other evidence in the record for this alleged distinction. Nor is Patent Owner’s argument based on the capability of computers to process data in 2003 (PO Resp. 47–48) supported by any proper citation to the record, only a single reference to Dr. Emblom’s declaration, without a page or paragraph number to guide us.⁹

⁹ Dr. Emblom’s cursory discussion of “computing power” (Emblom Decl. p. 15) cites no supporting evidence and is entitled to little weight. 37 C.F.R.

In summary, for the foregoing reasons, we are persuaded by a preponderance of the evidence that a person of ordinary skill in 2003 would have combined the teachings of Kiefer and Assanelli. Accordingly, for the reasons set forth above, we determine that by a preponderance of the evidence that claims 1–21 of the '138 patent would have been obvious over Kiefer and Assanelli.

*G. Obviousness of Claims 8, 9, 14, 15, 20, and 21
over Kiefer, Assanelli, and Palusamy*

Petitioner contends that each element of dependent claims 8, 9, 14, 15, 20, and 21 is found in these references together. Pet. 46–53. Petitioner provides an analysis that relies on its previous analysis of claim 1 and the other claims from which they depend. Pet. 53. Petitioner contends Kiefer and Assanelli, together, disclose all the elements of the claims from which claims 8, 9, 14, 15, 20, and 21 depend. Pet. 53. Petitioner also provides supporting testimony from its expert, Dr. Rodgers. Rodgers Decl. ¶¶ 222–226.

Claims 8, 9, 14, 15, 20, and 21 each contain the additional limitation: repeating the steps (a) to (f) for sequential inspection of the same tubular good and analyzing changes which have occurred over a period of time to predict when failure is likely to occur, and to avoid failure while maximizing use of the tubular good.

To meet this “sequential inspection over time” limitation, Petitioner relies on Palusamy. Pet. 53 (citing Rodgers Decl. ¶ 223). Palusamy is titled “Corrosion-Erosion Trend Monitoring and Diagnostic System.” Ex. 1031

§ 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”)

(54). Petitioner describes Palusamy as disclosing that the wall thinning of tubulars can be monitored by sequential inspection and data storage of the tubular over time. Pet. 52 (citing Ex. 1031, 1:50–64). Dr. Rodgers describes Palusamy as disclosing “determining thinning rate by comparing sequentially measured values.” Rodgers Decl. ¶ 224. He testifies that a person of ordinary skill “would understand that the purpose of determining a trend in thinning rate would be to predict ‘when failure is likely to occur,’ as described in the ‘138 Patent.” *Id.* He also testifies that Palusamy describes that its disclosure should be applied to tubular goods. *Id.* at ¶ 225 (citing Ex. 1031, 10:11–16). And he further testifies that “Palusamy describes how . . . the wall thinning rate can be used to predict failure while maximizing the life of a tubular.” *Id.* at ¶ 226 (citing Ex. 1031, 1:46–49). We find the description of Palusamy in the Petition and the supporting testimony by Dr. Rodgers to be credible in describing Palusamy.

Petitioner contends also that there is a rationale for combining Palusamy’s disclosure with that of Kiefer and Assanelli, and that the combination “would have worked.” *Id.* at 53–54, Rodgers Decl. ¶¶ 227–231. The reasons presented track those discussed above for combining Kiefer and Assanelli, namely, (1) interrelated teachings, (2) background knowledge and common sense of those skilled in the art, and (3) market forces. Pet. 53–56. For the reasons previously stated with respect to combining Kiefer and Assanelli, we find that there was a sufficient rationale for combining those references with Palusamy, and that the combination would have worked. Rodgers Decl. ¶¶ 227–232. Specifically, both Kiefer and Assanelli disclose methods for scanning tubulars to determine variations

in wall thickness. *See supra*. Palusamy further teaches that this information can be saved and used when a tubular is re-inspected to analyze the defects in a tubular over time. This would have led to efficiencies and lower costs that would have driven a person of ordinary skill to combine Palusamy's teachings with those of Kiefer and Assanelli. Rodgers Decl. ¶¶ 230–231.

Claims 9, 15, and 21 contain the additional limitation that the claimed method is “applied to the inspection of tubular goods for use in oil and gas exploration or production.” Petitioner relies on Kiefer and Assanelli to meet this additional limitation. Pet. 53. This limitation is not contested by Patent Owner.

Patent Owner agrees that Palusamy describes a method for monitoring the change in wall thickness of a pipe that may occur over time. PO Resp. 29. Patent Owner also agrees that in Palusamy, the wall of a work-piece is measured periodically and compared to an earlier measurement and from multiple measurements over a course of time a trend line predicting when replacement or maintenance of the work-piece may be developed. *Id.* But Patent Owner asserts: “There is no indication that Palusamy stores ultrasonic information representing the thickness of partially over-lapping segments of a pipe associated with positional data in a computer readable format and uses data contained in that format in calculations which predict the response of a work-piece to stressors.” *Id.* (emphasis omitted).

We are not persuaded by this argument because, as noted *supra*, Petitioner relies on Kiefer and Assanelli, not Palusamy, for these features. Patent Owner acknowledges that in Palusamy, “[t]he wall of a work-piece is measured periodically and compared to an earlier measurement and from

multiple measurements over a course of time a trend line predicting when replacement or maintenance of the work-piece may be developed.” Prelim. Resp. 31. Patent Owner further acknowledges that Palusamy “teaches . . . that periodic inspection of a physical object’s wear over a course of time may be predictive of the life of a tubular member.” *Id.* at 31–32. Petitioner relies on Palusamy for these teachings, not for the computation of stresses. Pet. 52–53.

Patent Owner’s argument that Kiefer, Assanelli, and Palusamy would not have been combined includes an additional argument that is based not on Palusamy, but on Lam. PO Resp. 49–50. Specifically, as to Lam, Patent Owner makes the argument that because Lam does not

suggest that data collected from ultrasonic inspection data be processed by computer running FEM software . . . [a] reasonable inference can be made Lam did not say that because, if it could even be done in 2001, Lam did not know that could be done (that is, it was not obvious to Lam that it could be done).

Id. at 48. This argument is speculation about a reference not even involved in the remaining challenges before us. Moreover, the same argument could be made about any combination of references, namely, that the absence of a particular teaching in one reference demonstrates the non-obviousness of making the combination. The law is otherwise. One cannot show non-obviousness by attacking references individually where obviousness is based on combinations of references. *See In re Keller*, 642 F.2d 413, 426 (CCPA 1981); *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986).

We are, thus, persuaded by Petitioner’s reasoning and Dr. Rodgers’ testimony that by a preponderance of the evidence, the combination of

Kiefer Assanelli, and Palusamy meets all the limitations of claims 8, 9, 14, 15, 20, and 21, and further, there is a rationale for combining the references. Based on the foregoing, therefore, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 8, 9, 14, 15, 20, and 21 would have been obvious over Kiefer, Assanelli, and Palusamy.

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IV. MOTIONS

There are two pending motions, both filed by Patent Owner.¹¹ Because they address the same subject matter we will treat them together.

1. Motion to Exclude

Patent Owner moves to exclude certain articles (Exhibits 1035, 1037, 1038, and 1039) submitted with Dr. Rodgers' Supplemental Declaration. Paper 30.¹² Patent Owner also moves to exclude Dr. Rodgers' testimony regarding those documents. *Id.* at 3–7. According to Patent Owner, “the Supplemental Deposition of Dr. Rodgers showed that his Supplemental Declaration was without foundation, none of the above referenced new publications were applicable to the field of art to which the invention pertains and would not have been publications which a [person of ordinary

¹⁰ Patent Owner has presented no evidence on the “Graham Factors.” *See supra.*

¹¹ Previously, the Board denied a motion by Petitioner to strike Dr. Emblom's testimony. Paper 34.

¹² The same articles were submitted in IPR2017-00860 as Exhibits 1028, 1030, 1031, and 1032, respectively.

skill] (in the field of art to which the invention pertains) would be expected to have knowledge.” *Id.* at 3. Patent Owner makes a similar argument for Exhibit 1015, also referred to by Dr. Rodgers in his Supplemental Declaration. *Id.* at 5.

Patent Owner further alleges that “Dr. Rodgers also admitted that Assanelli does not disclose what type of computer was allegedly used to perform such finite element method – that is, whether such a computer was a type that was available to a 2003 [person of ordinary skill] in the field of art in question, or some ‘main-frame’ available only to government (e.g., ‘NASA’), or cutting edge universities (e.g., ‘MIT’).” *Id.* at 5–6.

Finally, Patent Owner contends that the above articles are “new matter” and should be stricken for that reason. *Id.* at 7.

2. Motion for Observations

Patent Owner has also filed a motion seeking to have the Board enter and consider observations concerning its cross-examination of Dr. Rodgers on his Supplemental Declaration (Ex. 1027) filed with Petitioner’s Reply. Paper 31. Petitioner has filed a Response to the motion. Paper 35. This motion cites much of the same cross-examination of Dr. Rodgers as the motion to exclude regarding Exhibits 1015, 1035, 1037, 1038, and 1039 and makes the same arguments as the motion to exclude. Paper 31, 1–4. The motion also cites cross-examination testimony of Dr. Rodgers regarding his testimony on Assanelli and the level of skill in the art. *Id.* at 4–7.

Petitioner responds “[t]hese articles prove that Patent Owner’s expert, William Emblom, was incorrect when he swore [finite element analysis]

computer technology did not exist at this University until after 2003.” Paper 35, 2.

3. Discussion

We do not rely on Exhibits 1015, 1035, 1037, 1038, or 1039. Therefore, the motion to exclude is denied as moot insofar as it relates to those exhibits and Dr. Rodger’s testimony concerning them. We do rely on Dr. Rodger’s supplemental testimony regarding the impracticality of performing Assanelli’s finite element calculations by hand. Rodgers Supp. Decl. ¶ 159. While we do not understand Patent Owner’s motion to be directed to this testimony, we want to make it clear that this testimony is not excluded.

The motion for observations, likewise, is moot insofar as it relates to Exhibits 1035, 1037, 1038, and 1039. We do not rely on those exhibits, or the testimony of Dr. Rodgers or that of Dr. Emblom concerning those exhibits cited in connection with the motion and the opposition. We have considered Patent Owner’s observations and Petitioner’s responses as to the other issues addressed in the motion.

V. OTHER MATTERS

Patent Owner states a challenge to these proceedings under the United States Constitution. Pet. 51–52. This issue was decided by the Supreme Court in *Oil States Energy Services, LLC v. Greene’s Energy Group, LLC*, 138 S. Ct. 1365 (2018).

VI. SUMMARY

Petitioner has demonstrated, by a preponderance of the evidence, that (1) claims 1–21 of the ’138 patent are unpatentable under 35 U.S.C. § 103(a)

as obvious over Kiefer and Assanelli; and (2) claims 8, 9, 14, 15, 20, and 21 are unpatentable under 35 U.S.C. § 103(a) as obvious over Kiefer, Assanelli, and Palusamy.

VII. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–21 of the '138 patent are held *unpatentable*;

FURTHER ORDERED that Patent Owner's Motion to Exclude is denied; and

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

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