

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GODBERSEN-SMITH CONSTRUCTION COMPANY
d/b/a GOMACO CORPORATION,
Petitioner,

v.

GUNTERT & ZIMMERMAN CONST. DIV., INC.,
Patent Owner.

Case PGR2024-00026
U.S. Patent No. 11,772,723

DECLARATION OF KENNETH “MARK” BRYDEN

REDACTED VERSION

I. INTRODUCTION

I, Kenneth “Mark” Bryden, declare:

1. I am a Professor in the Department of Mechanical Engineering at Iowa State University, where I have taught courses and performed research in Mechanical Engineering, including engineering design, energy systems, combustion, modeling, simulation, and decision science since 1998. I am a retained technical expert on behalf of Guntert & Zimmerman Const. Div., Inc., (“G&Z”) in the above captioned matter. I have personal knowledge of the facts disclosed herein and, if called as a witness, I could and would testify regarding the opinions disclosed herein.

II. EXPERIENCE AND QUALIFICATIONS

A. Curriculum Vitae

2. Attached hereto as Appendix A is a true and correct copy of my abbreviated Curriculum Vitae (CV). I summarize some of the relevant information regarding my CV as follows.

3. I received a Bachelor of Science degree in General Engineering from Idaho State University in 1977, a Master of Science degree in Mechanical Engineering from the University of Wisconsin–Madison in 1993, and PhD in Mechanical Engineering from the University of Wisconsin–Madison in 1998.

4. I am a Professor in the Department of Mechanical Engineering at Iowa State University, where I have been a faculty member since 1998. In addition, I am the program director of Decision Science Program in the Ames National Laboratory and have held this position since 2006. The Ames National Laboratory is a U.S. Department of Energy National Laboratory managed by Iowa State University.

5. From 1977 to 1991 I worked at Westinghouse Electric Corporation where I was a technical manager for more than ten years. Specifically, I held a number of engineering and technical management positions, including shift supervisor of a nuclear power plant, engineering manager responsible for planning and managing outages for three nuclear power plants, and the radiological controls engineering manager responsible for three nuclear power plants and one of the few nuclear fuel handling facilities in the world.

6. I have more than 40 years’ experience in engineering, and I have authored or coauthored more than 200 publications, including the textbook *Combustion Engineering*. I have a wide range of engineering experiences that include power plant management and operations, design of energy systems, farm machinery engineering, system integration, and engineering design and decision making. I have received two U.S. Patents. In addition, I am a co-founder of two software companies AgSolver Inc. and Praxik LLC.

7. In my capacity as a Professor at Iowa State University, my responsibilities include: teaching undergraduate and graduate students; performing research in mechanical engineering; mentoring masters students, PhD students, and postdoctoral fellows; supervising research scientists; and serving on various university committees. My current research includes the control and design of complex energy systems, dynamic systems modeling, and engineering design and decision making. My research has been funded by grants from the U.S. Department of Energy, Deere & Co., the U.S. Army, and others.

8. I am the recipient of the 2013 ASME Melville Medal,¹ three R&D 100 Awards² (2006, 2009, 2010), and a 2010 National Excellence in Technology Transfer from the National Federal Laboratory Consortium. In addition, I am a fellow of the ASME and an associate fellow of the AIAA. I have reviewed and evaluated research papers on a wide range of engineering topics, and I am

¹ The Melville Medal was first awarded in 1927 and is the highest honor for the best original technical paper published in the *ASME Transactions* in the previous two years period.

² The R&D 100 Awards, sponsored by R&D Magazine, identify the top 100 technological innovations of the past year.

currently an Associate Editor for the International Journal of Energy for a Clean Environment.

B. Compensation

9. My compensation is for my work and is based solely on the amount of time that I devote to activity related to this case (I am paid on an hourly basis) and is in no way affected by any opinions I render. I receive no other compensation from work on this action. My compensation is not dependent on the outcome of this matter. I have no financial interest in the outcome of this matter.

III. MATERIALS CONSIDERED

10. In forming my opinions, I have considered Petitioner’s and G&Z’s exhibits and the papers filed in this IPR in preparation for this declaration. My opinions are based on my experience, knowledge of the relevant art, the documents discussed in the declaration.

IV. PERSON OF ORDINARY SKILL IN THE ART

11. I have been informed of the following legal standards that I have used as a framework in forming my opinion:

12. Counsel informed me that a “person of ordinary skill in the art” (“POSITA”) is a hypothetical person who is presumed to be familiar with the relevant scientific field and its literature at the time of the invention for the relevant patents. I understand that this hypothetical person is also a person of ordinary

creativity, capable of understanding the scientific principles applicable to the pertinent field.

13. I understand that the factors to be considered in determining the level of ordinary skill in the art to be: (1) the educational level of active workers in the field, including the named inventors of the patent; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; and (5) the sophistication of the technology in the art.

14. I understand that G&Z applied Petitioner’s definition of a POSITA, which is, one who “would have had at least a four-year degree in mechanical engineering or a closely related field and at least two years of experience designing, developing, or operating heavy machinery, including their components and control systems.” Pet. at 10. “Additional experience could substitute for a formal degree, and an advanced degree could substitute for experience.” *Id.* I meet these requirements as Section I depicts.

V. LEGAL STANDARDS

A. Claim Construction

15. I understand that a claim of a patent generally shall be construed in accordance with the ordinary and customary meaning of such claim as understood

by a POSITA based upon the intrinsic and extrinsic evidence. I have been informed that claim construction is a legal issue for the Court to decide.

B. Obviousness

16. I have been informed that the analysis of obviousness involves several factual inquiries including the scope and content of the prior art, the differences between the prior art and the claim, and the level of ordinary skill in the art at the time of the invention.

17. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

18. Additionally, I understand that a patent is likely to be invalid for obviousness if a person of ordinary skill in the art can implement a predictable variation or if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent’s claims. A combination is not obvious, however, where the combination cannot be implemented without undue experimentation or when the motivation to create the combination comes from hindsight.

C. Written Description

19. I have been informed that a claim is valid under the written description requirement of 35 U.S.C. §112 when the descriptions in the patent

show that the applicant invented what is claimed. The patent applicant does not have to use any particular form of disclosure to describe the subject matter claimed. Rather, the test is whether the disclosure in the patent reasonably conveys to one skilled in the art that the applicant had possession of the claimed subject matter as of the filing date of the application. This test requires an objective inquiry into the specification from the perspective of a person of ordinary skill in the art. I also have been informed that the adequacy of the description of an invention depends on the nature of the claims and the complexity of the technology. Given this perspective, in some instances, a patent owner can rely on information that is well-known in the art to satisfy written description.

D. Objective Indicia of Nonobviousness

20. I have been informed that in assessing whether a claimed invention is obvious, secondary considerations may weigh towards the non-obviousness of the invention, including the following, which should be considered in determining the obviousness of the claim:

- Whether the claimed invention satisfied a long-felt need;
- Whether the claimed invention was preceded by a history of failures by others to solve a problem or problems solved by such invention;
- Whether the claimed invention achieved a surprising or unexpected result
- Whether the claimed invention has achieved commercial success;

- Whether the claimed invention has been copied; and
- Whether the claimed invention was the subject of skepticism by the industry.

VI. OVERVIEW OF THE '723 PATENT

21. The '723 Patent describes a novel paving machine that repositions its swing leg and/or crawler track on the fly. No traditional paving machine had these capabilities, including the *CIII* and *Rio* reference cited against the Challenged Claims. Prior to G&Z's invention, repositioning a traditional paving machine's swing leg/crawler track required the operator to stop the machine, support the machine, and lift the crawler track lifted off the ground:

[W]hen repositioning the crawler tracks of a paving machine in accordance with conventional methods, the machine is initially appropriately supported so that a first one of the bolster swing leg-mounted crawler tracks can be lifted off the ground. The turnbuckle is then used to pivot the bolster swing leg until the jacking column and the associated crawler are at the desired (lateral) position and have the required crawler orientation.

'723 Patent at 4:57-61; *see also id.* at 4:57-5:22, 16:6-14. This process resulted in a very time-consuming and costly operation. *Id.*

22. The '723 Patent improved over the state-of-the-art with a paving machine that can reposition its swing legs and crawler tracks “on the fly” when the crawler track is moving and under load:

These swing legs can be coordinated electronically allowing ease of automatically or semi-automatically reconfiguring the machine to go into a transport position, an operational paving position, or to reposition jacking column and/or crawler track positions ***on the fly*** to avoid obstacles or severe grade deviations during paving.

’723 Patent at 15:65-16:3 (emphasis added); *id.* at 16:14-16 (“[T]he present disclosure provides for machines that can adjust leg and crawler track location while in operation (***‘on the fly’***).”), Claim 1 (“slew gear drive . . . capable of steering the crawler track under load without lifting the crawler track.”).

23. In this operation, a swing leg hydraulic actuator, a slew drive, and angular position transducers work in connection to achieve the coordinated movement of the swing leg and crawler track while moving and under load. 723 Patent at 6:19-7:25. For example, in keeping the machine in an operational paving position, the swing leg’s hydraulic actuator and the crawler track’s slew drive work in connection with angular position transducers:

A closed loop system feedback system that connects the hydraulic actuator for the swing leg, the rotary power drive for the crawler If the swing leg migrates away from a preset angle, the swing leg hydraulic cylinder is actuated to maintain the preset angle and at the same time the necessary adjustments to the crawler track orientation are made with the hydraulic rotary power drive.

’723 Patent at 6:47-54; *see also id.* at 6:25-33 (describing “pivot[ing] the crawler track relative to the associated jacking column to keep the crawler tracks oriented in the paving direction when the angular orientation of the swing leg changes). This coordinated process also enables the relocation of the swing leg/crawler track (for example, to maneuver around paving obstacles). *See* ’723 Patent at 16:44-53 (“While the paving machine is moving, allowing automatic repositioning of one or more swing legs (inclusive of jacking column and crawler tracks) into new positions provides for the ability to avoid obstacles (e.g., manholes, guard rails, posts, etc.)”), Claim 6.

24. Thus, the ’723 Patent discloses a slipform paver capable of on-the-fly coordinated swing leg and crawler track steering while under load, which provides seamless maneuverability while paving, transforming the machine between paving and transport modes, and navigating around a jobsite.

VII. THE RELEVANT ASSERTED REFERENCES

A. CIII (Ex. 1005)

25. CIII is a traditional paving machine that implements the conventional swing leg/crawler track relocation process. Indeed, Petitioner acknowledges that “to swing the leg, an operator *raises the crawler track off the ground.*” Pet. at 16 (emphasis added); *see also* CIII at 253-55 (disclosing that to transform the machine, the crawler track is also lifted off the ground).

26. CIII’s swing leg includes locking pins that hold the swing leg in place while under load and which are only removed after the machine is supported, the crawler track is lifted off the ground, and the hydraulic pivot cylinder is engaged to pivot the swing leg:

[An operator] removes the pin locking the leg in place, and holds a switch to extend or retract the pivot cylinder until the leg reaches the desired position.

Pet. at 16. Accordingly, unlike the ’723 Patent’s on-the-fly operation, which enables the coordinated movements of the swing leg and crawler track under load, CIII machine must be stopped, supported, the track lifted off the ground, and the locking pin removed before there is any movement of the swing leg.

B. Rio (Ex. 1006)

27. Rio, like CIII, also requires the operator to stop the machine and raise the crawler track before adjusting the swing leg. Similar to CIII, Rio’s anti-swing device is only disengaged from the swing leg after the track is raised:

First, the ***operator stops the machine 10*** and engages the parking brake which sends a brake set signal 116 to the controller 32 Next, . . . ***the lifting column 46 [is] raised relative to the machine frame 12 . . .*** . In response to receiving the permissive signals indicating ***that the machine is safely stopped***, the controller 32 activates ***the anti-swing actuator 85*** and the anti-rotate actuator 98 to release the corresponding

protrusions 86, 102 from engagement with the respective receptacles 88,96.

Rio at 7:62-8:21-27 (emphasis added). Just like CIII, the Rio machine must be stopped, the track must be lifted off the ground, and the anti-swing device disengaged before any movement of the swing leg is permitted.

VIII. CLAIM CONSTRUCTION

A. **“A Crawler Track Coupled to a Yoke Which is Rotatably Coupled to the Jacking Column” and “a Slew Gear Drive Secured at a Lower End of the Inner Tube and to a Top of the Yoke to Translate Relative Rotational Movements Between the Jacking Column and the Crawler Track About the Upright Axis”**

28. A POSITA would understand the term “a crawler track coupled to a yoke which is rotatably coupled to the jacking column” as meaning one side of the slew drive is coupled to the jacking column, one side of the slew drive is coupled to the crawler track, and neither cylinder of the jacking column rotates along with the crawler track.

29. The ’723 Patent’s express claim language requires a slew drive that rotatably couples the crawler track to the jacking column and rotates the crawler track relative to the entire jacking column:

A paving machine comprising:

* * *

a crawler track coupled to a yoke which is *rotatably coupled to the jacking column*;

a slew gear drive secured at a lower end of the inner tube and to a top of the yoke *to translate relative rotational movements between the jacking column and the crawler track about the upright axis . . .*

'723 Patent at Claim 1 (emphasis added). This express language does not recite causing the crawler track to rotate relative to a *portion* of the jacking column, it recites causing the crawler track to rotate relative to the jacking column, full stop.

30. The plain reading of the claims is entirely consistent with every embodiment of the invention disclosed in the '723 Patent, which describes coupling a slew drive to bottom of a rotationally-fixed jacking column, such that the crawler track rotates relative to the entire jacking column. '723 Patent at Abstract (“The jacking column can include telescoping outer and inner tubes The slew gear drive can be secured between the inner tube and a yoke”), 8:67-9:2 (The crawlers are mounted to the lower ends of the jacking columns, and they are rotatable relative to the jacking columns about vertical axes), 11:67-12:2 (Supports 74 extend across opening 69 and secure the can with transducer 70 at the rotational center between the jacking column and the yoke.), 12:9-11 (“a signal that indicates the angular position of yoke 62 relative to jacking column 14 and any changes in the angular position due to rotational movements of the yoke”), 12:59-63 (“The onboard computer then signals by how much worm gear drive 60 must rotationally

adjust the orientation of yoke 62 and crawler tracks 16 to again align the crawler tracks with the paving direction.”), 13:27-32 (“With the crawlers resting on the ground and initially facing in the paving direction 18, they are rotated 90° about the vertical jacking column axis with worm gear drive 60 into a position in which they are substantially transverse to the paving direction.”).

31. Thus, in my opinion, a POSITA would applying the plain and ordinary meaning for these limitations which excludes arrangements where a rotary actuator turns either cylinder of the jacking column along with the crawler track.

IX. GROUND 1: IN MY OPINION, THE CLAIMED INVENTION IS PATENTABLE OVER THE CIII-RIO-FILES COMBINATION (ALL CLAIMS)

A. CIII in View of Rio Does Not Render Obvious “A Crawler Track Coupled to a Yoke Which is Rotatably Coupled to the Jacking Column” or “a Slew Gear Drive Secured at a Lower End of the Inner Tube and to a Top of the Yoke to Translate Relative Rotational Movements Between the Jacking Column and the Crawler Track About the Upright Axis” (Independent Claim 1)

32. In my opinion, the Challenged Claims are patentable because neither CIII nor Rio discloses a crawler track rotatably coupled to a jacking column, and Petitioner’s argument for combining CIII and Rio such that CIII’s crawler track would rotate with respect to the entirety of its jacking column is the product of looking to the ’723 Patent itself.

1. Neither CIII nor Rio Expressly Discloses “a crawler track rotatably coupled to the jacking column”

33. In my opinion, neither CIII nor Rio discloses a swing leg assembly with a crawler track rotatably coupled to a jacking column, such the crawler track rotates relative to the entire jacking column. Rather both CIII and Rio disclose assemblies where the inner tube of the jacking column rotates along the crawler track. CIII at 8-76 (“On 4-track capable machines, the track yoke is bolted to the base plate of the inner guide tube.”); Rio at 5:32-6:6 (discussing the rotation of the inner tubular member 58 using a key and keyway arrangement to permit sliding between it and the outer cylinder 66); *see also* ’749 FWD at 11-12, 77 (determining that Rio discloses a complex jacking column with an internal “key and keyway arrangement” controlling the rotation of the “inner tubular member” of its lifting column that “is connected to the bracket 54” which “may be a simple axial wheel support . . . or may support a track section.”)

34. The jacking column of the ’723 Patent similarly includes inner and outer tubes. ’723 Patent at 11:22-41. However, unlike the fixed connections between the inner cylinders and crawler tracks disclosed in CIII and Rio, the claimed crawler track is rotatably coupled to the jacking column in its entirety. In fact, I understand that Dr. Singhose acknowledged during his deposition that Rio does not expressly disclose a crawler track rotatably coupled to a jacking column. Ex. 2009 (“Singhose Tr. II”) at 18:3-18, 30:12-25.

**2. Neither CIII nor Rio Expressly Discloses a Slew Drive
Coupled to a Jacking Column and a Crawler Track**

35. In my opinion, CIII and Rio also do not disclose coupling “a slew gear drive secured at a lower end of the inner tube and to a top of the yoke to translate relative rotational movements between the jacking column and the crawler track.”

Ex. 1001, Claim 1.

36. Petitioner admits that CIII does not disclose a slew drive (Pet. at 14, 31), and Rio is clear that its second rotary actuator turns the asphalt milling machine’s crawler track by rotating the portion of the jacking column that is fixedly coupled to the crawler track:

The second actuator 44 is connected to the lifting column 46 and is ***adapted to cause at least a portion of the lifting column 46 to rotate about a lifting column axis 48*** that is orientated generally vertically relative to the work machine 12.

Rio at 4:56-60 (emphasis added); *id.* at 5:31-61 (The rotary actuator “causes the cylinder 66 to rotate as the cylinder flange 68 slides on the outer tubular member 60” of the lifting column). The cylinder 66 is engaged with the inner tubular member 58 by a pair of keys 74” and the corresponding key and keyway prevents relative rotational movement between the crawler track, inner tubular 58, and cylinder 66. *Id.* at 5:63-6:6.

37. In reading Rio, a POSITA would appreciate that Rio does not describe *any* embodiments in which its second rotary actuator does not “cause at least a portion of the lifting column 46 to rotate about a lifting column axis 48.”

Therefore, in my opinion, Rio fails to suggest to a POSITA “a slew gear drive secured at a lower end of the inner tube and to a top of the yoke to translate relative rotational movements between the jacking column and the crawler track.”

3. Petitioner’s Proposed Combination of *Rio* and *CIII* Uses the ’723 Patent as a Guide

38. Petitioner’s proposal to modify “CIII’s leg assembly by substituting its steering cylinder for Rio’s rotary actuator 44 positioned between the bottom of the jacking column and the top of the yoke associated with each crawler track, such that the rotary actuator translates relative rotational movements between the jacking column and the crawler track” is the product of looking to the ’723 Patent for guidance. Pet. at 82; *see also id.* at 81.

(a) The “State-of-the-Art” References are Not “State-of-the-Art” and Do Not Establish That it Was Well Known to Rotatably Couple a Crawler Track to a Jacking Column

39. I understand that Petitioner cites several “state-of-the-art references” for the proposition that “this design was well known.” Pet. at 81; *see also id.* at 34-35. I disagree. None of the many “state-of-the-art” references cited in the

Petition—which are many decades old—disclose or even fairly suggest rotatably coupling a crawler track to a jacking column.

40. Miller does nothing to cure CIII and Rio’s deficiencies because its steering housing 122 is not a slew drive and is not coupled to the jacking column and crawler track, as claimed. Miller’s steering housing 122 is connected to the walking beam of the machine’s frame, not the inner tube of a jacking column. *See* Miller at 5:21-26 (describing that the “extendable support member” attaches to bogey mount 66, 68 not “steering housing 122”), 6:8-11 (“A steering spindle is provided at the ends of each walking beam. Thus, as previously described, the walking beam 64 has the steering spindles or housings 122 at its ends”);

41. Littman’s prime mover is far afield from the paving machine disclosed in the ’723 Patent and fails to disclose a slew drive between a jacking column and a crawler track. *See* Littman at 1:11-27; Ex. 2008 (Singhose Tr. I”) at 152:1-153:12 (stating that Littman’s use in road construction would be similar to a forklift). Rather than being coupled to a jacking column and crawler track, Littman’s rotary actuator is located fully within the telescoping second section 70 that Petitioner likens to a jacking column. Littman at Figs. 4, 5. Indeed, rather than disclose the type of upright jacking columns found in the ’723 Patent, Littman’s elongated legs articulate at angles during operation and, as such, its

wheels are subject to an entirely different set of forces than those seen in the claimed paving machine in the '723 Patent. Littman at Fig. 2.

42. Whitaker’s supporting means 26 (which Petitioner likens to the claimed jacking column) has rectangular upper telescopic sections and a round lower section 28 that is fixedly coupled to the crawler track and ring gear 31. Whitaker at Fig. 3. Motor 32 is mounted on the lower end of the support shaft 26 and rotates lower section 28 in conjunction with its crawler track. *Id.* Accordingly, like CIII and Rio, Whitaker discloses rotating the crawler track along with a portion of the jacking column. Thus, Whitaker also does not establish that it “was well known” to rotate a crawler track relative to an entire jacking column, let alone doing so with a slew drive coupled to the jacking column and crawler track such that the crawler track rotates relative to the entire jacking column. Pet. at 45.

43. Johns also fails to establish that it was “well known” to place a slew drive physically between a jacking column and crawler track because Johns “mobile work platform” entirely lacks a swing leg assembly and jacking column. It is also not comparable in weight to a conventional large paving machine. Johns at Fig. 2; Singhose Tr. II at 23:5-14. It also turns wheels, which are much easier to turn than crawler tracks.

44. In my opinion, Petitioner’s primary references do not teach or suggest rotatably coupling a crawler track to a jacking column with a slew drive. And far

from confirming that the claimed design was well known, the “state-of-the-art” references disclose several ways to turn a wheel or a crawler track with a rotary actuator that *do not* involve (1) rotating the crawler track with respect to an entire jacking column or (2) coupling a slew drive to a crawler track and jacking column to cause such rotational movement.

**(b) Petitioner’s Proposed Combination Merely Uses the
’723 Patent to Retrace the Inventors Steps**

45. In my opinion, because none of the art disclose the claimed limitations, Petitioner’s proposal to rotatably couple CIII’s crawler track to its jacking column with Rio’s rotary actuator simply uses the ’723 Patent to retrace the inventor’s path.

**B. The CIII-Rio-Files Combination Does Not Disclose Nor Render
Obvious the Claimed Processor (Claim 7)**

46. Independent Claim 1 recites rotating the crawler track when “***under load without lifting the crawler track,***” which limits the claimed invention to the “on-the-fly steering embodiment. ’723 Patent at Claim 1 (emphasis added). Claim 7 further requires a processor that coordinates the steering of the crawler track in response to changes in the orientation of the swing leg. The CIII-Rio combination³

³ Because Petitioner alleges focuses on CIII and Rio for Claim 7 (and Claim 6, I discuss below), I focus on these two references in my analysis. See Pet. at 96, 98.

does not render obvious the claimed processor, providing the coordination with the angular position transducers in determining the angular position change of the swing leg and sending signals to rotate the crawler track *when moving and under load* (the on-the-fly embodiment), because CIII-Rio’s machine holds the swing leg in place when under load such that there is no swing leg angular position change for the processor to determine. Pet. at 98-103.

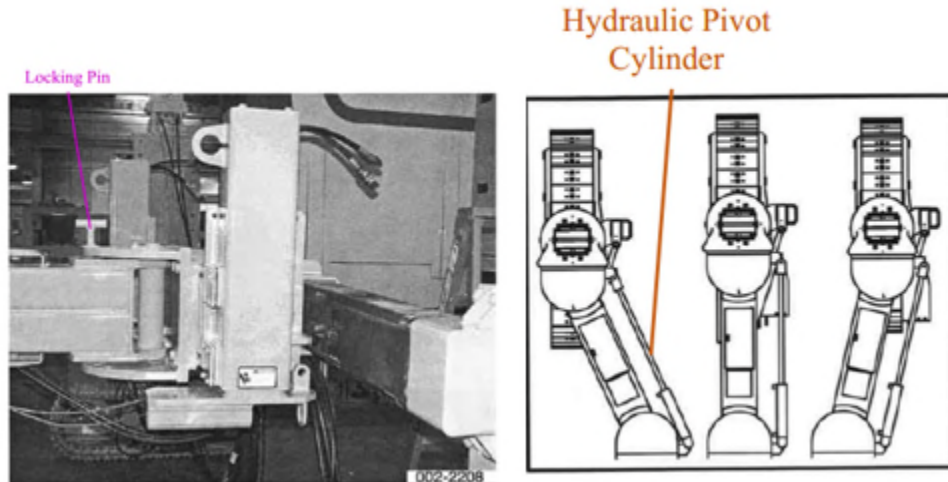
47. A POSITA understands that CIII is a traditional paving machine that required the machine to be stopped and crawler track to be lifted off the ground anytime the swing leg/crawler track position needed to be changed, as Petitioner admits :

To swing the leg, an operator ***raises the crawler track off the ground*** with the jacking column, removes the pin locking the leg in place, and holds a switch to extend or retract the pivot cylinder until the leg reaches the desired position.

Pet. at 16 (emphasis added); CIII at 85 (describing how CIII’s swing leg/crawler track is repositioned by lifting the crawler track off the ground). More specifically, only when the machine is stopped and the crawler track raised off the ground, is the locking pin⁴ (used to keep the swing leg from moving while under load) disengaged

⁴ CIII’s three-track configuration includes locking pins while its four-track configuration includes turnbuckles, each are used to keep the swing leg locked in

to thereby allow the hydraulic pivot cylinder to move the swing leg/crawler track to the desired position, as the figures below depict.



Pet. at 16-17 (citing CIII at 85, 79-80); *see also* Pet. at 48 (“CIII discloses pivoting the swing leg about a vertical axis of the hinge bracket attached to the frame **by removing the locking pin from the hinge bracket** and ‘mov[ing] the swing control switch to extend the swing cylinder.’”) (emphasis added) (citing CIII at 80).

48. A POSITA would also understand that Rio’s swing leg and crawler movement likewise occurs when the machine is stopped and the lifting column lifted off the ground:

place when under load. *See* Pet. at 18; ’723 Patent at 3:15-36; Ex. 2013 at Fig. 3 (demonstrating that traditional paving machines have two locking pins for each swing leg).

First, the ***operator stops the machine 10*** and engages the parking brake which sends a brake set signal 116 to the controller 32 Next, . . . ***the lifting column 46 [is] raised relative to the machine frame 12*** In response to receiving the permissive signals indicating ***that the machine is safely stopped***, the controller 32 activates ***the anti-swing actuator 85*** and the anti-rotate actuator 98 to release the corresponding protrusions 86, 102 from engagement with the respective receptacles 88,96.

Rio at 7:62-8:27 (emphasis added)

49. In the CIII-Rio combination, Petitioner replaces CIII’s locking pin (turnbuckles) with Rio’s anti-swing device “to fully automate rotation.” See Pet. at 38. But even with this substitution, the anti-swing device is only disengaged when “the machine is safely stopped” and the “lifting column raised.” Rio at 7:62-8:27. Following these steps, CIII’s hydraulic pivot cylinder/Rio’s linear actuator is activated and works in coordination with the rotary actuator to relocate the swing leg/crawler track to the desired position. See Pet. at 37-38; Pet. at 16 (acknowledging that CIII’s hydraulic pivot cylinder is engaged only after the crawler track is raised off the ground and the locking pin (or, in this case, the anti-swing device) disengaged).

50. I note that Dr. Singhose confirmed the use of a locking mechanism in the CIII-Rio combination:

So the pins --yeah, it's somewhat similar. The pins in the CIII that we talked about before, just to clarify, those were pins that were holding the swing arm in place to the frame, and then also holding the jacking column in place relative to the swing arm. But yeah, it's very similar idea is that you ***have manual pins that help lock the CIII in place. Rio is using a very similar locking pin device***, but it's telling you that you can control it with a computer, you can turn it on and off with a computer and a control system

Singhose Tr. I at 104:7-19 (emphasis added); *see also id.* at 52:22-54:1, 57:9-13 (testifying that this CIII's turnbuckles (locking pins) are “designed ***to hold those swing arms in place*** once you've swung them into the place that you want”) (emphasis added).

51. Therefore, a POSITA would appreciate that the CIII-Rio combination would have, at most, provided for automatic swing leg/crawler track repositioning when the machine is stopped and the swing leg/crawler track raised off the ground. In this regard, CIII-Rio's processor *only* coordinates with the angular position transducers when the machine is stationary and the swing leg/crawler track is raised off the ground and moved. Accordingly, in my opinion, the CIII-Rio combination does not disclose the claimed processor's coordinated performance with the angular position transducers when the swing leg/crawler track is moving and under load

C. CIII-Rio-Files Combination Does Not Disclose Nor Render Obvious a Swing Leg Configured to Relocate a Jacking Column With a Crawler Track While Moving and Under Load (Claim 6)

52. In my opinion, the CIII-Rio combination does not disclose nor render obvious the “swing leg is configured to relocate the jacking column with the crawler track while moving and under load”⁵ for at least two reasons. *First*, because the anti-swing device holds the swing leg in place when moving and under load, the CIII-Rio combination *only relocates the swing leg when the machine is stopped and not load bearing*. *Second*, Petitioner fails to show why it would have been obvious to modify the CIII-Rio combination in such a way that the swing leg is relocated while moving and under load, absent using the ’723 Patent.

1. The CIII-Rio Combination Does Not Disclose the Swing Leg Relocation Limitation Because it Relocates the Swing Leg When Stopped and Raised Off the Ground

53. The swing leg relocation limitation signifies the relocation of the swing leg, for example, to maneuver around obstacles while the swing leg/crawler track is moving and under load. It is my opinion that the CIII-Rio combination does not disclose this capability because its machine must be stopped and the crawler track must be lifted before attempting to relocate the swing leg .

⁵ Hereinafter I refer to this limitation as the “swing leg relocation” limitation.

54. The ’723 Patent describes and claims the on-the-fly relocation of the swing leg (inclusive of the jacking column and crawler track) when the machine is in operation. ’723 Patent at 16:14-16 (“[T]he present disclosure provides for machines that can ***adjust leg and crawler track location while in operation (‘on the fly’)***”) (emphasis added), Claim 6;. In particular, the swing leg is relocated through the coordinated use of a processor, angular position transducers, a slew gear drive, and a hydraulic swing leg actuator:

While a paving machine is moving, it is capable of automatically going from a working position to the narrow and predetermined profile of the transport position, ***relocating the crawler tracks attached to jacking columns via slew drives and transducers attached the swing legs***. The ***transducers can control adjustment via slew drives***

Id. at 16:24-32 (emphasis added).

While the paving machine is moving, allowing automatic repositioning of one or more swing legs (inclusive of jacking column and crawler tracks) into new positions provides for the ability to avoid obstacles (e.g., manholes, guard rails, posts, etc.) or large changes in grade. The adjustment implemented by the transducers coupled to the swing leg and crawler tracks

Id. at 16:44-53 (emphasis added); *see also id.* 6:47-54 (disclosing that the swing leg hydraulic cylinder is actuated to move the swing leg when under load).

55. A POSITA would recognize that the CIII-Rio combination is incapable of such relocation while the swing leg is moving and under load because the leg is *locked in place* via the anti-swing device (or locking pin). *See* Section IX.B above (I discuss that in the CIII-Rio combination, the machine must be stopped and the leg/tracked raised off the ground before the anti-swing device is disengaged and the leg moved). Accordingly, because CIII-Rio machine’s anti-swing device *prevents any swing leg movement when the machine is moving and under load*, the relocation of the swing leg is *only* performed when the leg is lifted off of the ground and the CIII-Rio processor executed for the repositioning calculations.

56. Given the aforementioned, Petitioner’s argument on swing leg relocation is premised on the faulty belief that the swing leg can be rotated when steering the crawler track. *See* Pet. at 96-97 (alleging that steering the crawler track “would have allowed the swing leg to be rotated.”). Petitioner’s state-of-the-art-evidence (*i.e.* Littman) provides no recourse because it does not discuss swing leg relocation, much less how the CIII-Rio combination’s current design even could be modified to relocate the swing leg as claimed. *See id.*

2. Petitioner Fails to Adequately Show Why it Would Have Been Obvious to Relocate CIII-Rio’s Swing Leg as Claimed

57. I understand that Petitioner also alleges that it would have been obvious to modify the CIII-Rio combination to arrive at swing leg relocation. I

disagree because no record evidence exists for demonstrating to a POSITA this swing leg relocation apart from the '723 Patent itself, and Petitioner does not address how the relocation would work given the CIII-Rio design, which I discussed above.

58. *First*, Petitioner’s I disagree with Petitioner’s suggestion that “it would have been obvious to provide the controls that allow the rotation of the swing legs while the machine was moving and under load” because the only evidence on record for swing leg relocation while moving is the '723 Patent itself. As I discussed above, to relocate the swing leg/track, both CIII and Rio teach stopping the machine and raising the track off the ground. Accordingly, neither reference discloses the controls and design required for the swing leg relocation as claimed.

59. Littman likewise does not disclose the required controls or design configuration because it simply discloses a stabilizer leg for a prime mover, missing entirely is a swing leg assembly. *See, e.g.*, Littman at Figs 2-3. With no evidence on record, it is my opinion that Petitioner uses the '723 Patent itself as a guide to allege that it would have been obvious to modify the CIII-Rio combination in the way claimed.

60. *Second*, Petitioner does not address how Rio’s controls would (or even could) work in relocating CIII-Rio’s swing leg when moving and under load

given that the *swing leg is locked and incapable of any movement*. The swing leg is only unlocked and pivoted to another location when stopped and the track raised, as the CIII-Rio design is intended to work. *See* Pet. at 37 (CIII-Rio combination uses CIII’s hydraulic pivot cylinder/Rio’s actuator to move the swing leg when the machine is stopped and the track non-load bearing), 38 (CIII-Rio combination uses Rio’s anti-swing device which is only deactivated when the machine is stopped and the crawler track is non-load bearing).

61. For at least the foregoing reasons, it is my opinion that the CIII-Rio-Files combination does not disclose nor render obvious the swing leg relocation limitation.

X. GROUND 2: IN MY OPINION, THE CIII-RIO-FILES-TAX COMBINATION DOES NOT TEACH NOR RENDER OBVIOUS THE SWING LEG RELOCATION LIMITATION

62. In my Petitioner’s addition of Tax also fails to show that CIII-Rio combination renders obvious the swing leg relocation limitation and does not rectify the deficiencies I identified above. Petitioner once more relies on the ’723 Patent as a guide because Tax does not disclose a paver swing leg assembly, let alone one that relocates the swing leg when moving and under load. Instead, Tax discloses a *crane vehicle* that includes four arms that are each respectively attached to a wheel. *See* Tax at 4:30-37 (describing the crane’s arms), Fig. 2; *see also id.* at 2:38-44 (depicting the conventional crane). Indeed, those skilled in the art would

not have looked to Tax’s crane for guidance in constructing a paving machine. Ex.

2007 (industry expert expressing skepticism of G&Z’s [REDACTED])

[REDACTED]
[REDACTED] (July 14, 2009 message from David Pope, President of Kinematics Manufacturing Inc.). Therefore, like CIII, Rio, and Littman, it is my opinion that Tax also provides no path for which a POSITA would have followed to relocate a paving machine’s swing leg (with a jacking column/crawler track) in the manner claimed. *See Otsuka Pharm. Co. v. Sandoz, Inc.*, 678 F.3d 1280, 1296 (Fed. Cir. 2012).

63. Finally, even if a POSITA would have looked to Tax’s teachings (they would not have), the CIII-Rio combination includes design features that dictate relocation only when the machine is stopped and the swing leg/crawler track raised, as I discussed above. Thus, CIII-Rio combination remains deficient even in view of Tax’s crane teaching, which provides no indication of how to rectify the deficiencies in the CIII-Rio combination.

XI. GROUND 3: IN MY OPINION, THE “DISPOSED ON” LIMITATION IS SUPPORTED IN THE ’723 PATENT

64. In my opinion, the ’723 Patent provides written description support under 35 U.S.C. § 112 for “a first angular position transducer . . . disposed on the modular frame or the swing leg to measure an angular position between the swing leg and the modular frame,” as recited in Independent Claim 1.

65. A POSITA comes to the ’723 Patent with the knowledge that angular position transducers measure the amount of rotation of one component of a system relative to another. *See, e.g.*, Ex. 2017 at 5; Ex. 2018; Singhose Tr. II at 11:6-12:18. In practice, the transducer is fixed to one component, and it measures the relative rotation of the other. *Id.* It is, generally speaking, a matter of preference and design *which* component the transducer is fixed to and which one it measures. Accordingly, a POSITA understands that there are only two locations to locate an angular position transducer to “measure an angular position between [a] swing leg and [a] modular frame”: It would be “disposed on the modular frame or the swing leg,” as claimed. ’723 Patent at Claim 1

66. In accordance with this well-known principle, the ’723 Patent discloses placing an “angular position transducer[] at the pivot connection for the swing leg at the hinge bracket.” *Id.* at 6:18-24. The hinge bracket is “in a fixed position relative to the bolster and the swing leg,” and the bolster is part of the frame. *Id.* at 9:40-47. The ’723 Patent does not specify which *part* of the pivot connection the transducer must be placed on, and it was well understood that an angular position transducer could be disposed on *either* component to measure the relative angle between them. *Id.* at 6:17-18.

67. I understand that Petitioner nevertheless argues that there is no written description for an angular position transducer disposed on the frame or swing leg

because the specification describes mounting the transducer on the hinge bracket. Pet. at 109-110 (alleging that because the angular position transducer is only on the hinge bracket, there is no written description support for disposed on the frame or swing leg). I disagree.

68. This interpretation misreads the specification, which describes the hinge bracket as part of the frame, and adopts an overly narrow interpretation of the phrase “disposed on” that is inconsistent with its plain and ordinary meaning and the intrinsic record.

69. *First*, because the specification and claims describe the hinge bracket as part of the **frame**, disposing an angular position transducer directly on the hinge bracket is tantamount to disposing it directly on the frame. As disclosed and as claimed, the paving machine of the ’723 Patent has six main parts: (1) a modular frame, (2) a plurality of swing legs, (3) a jacking column secured to each swing leg, (4) a crawler track rotatably coupled to each jacking column, (5) a slew gear secured to the jacking column and crawler track (via a yoke), and (6) angular position transducers for measuring the relative angular positions of the crawler tracks and swing legs. *See* ’723 Patent at Abstract and Claim 1.

70. The ’723 Patent describes the “hinge bracket” as the portion of the paving machine where each swing leg is “pivotally mounted.” ’723 Patent at 5:66-6:2 (“According to a first aspect of the present invention, each bolster swing leg is

pivotally mounted on a hinge bracket that is secured to the front (or aft) ends of the side bolsters of the paving machine.”). The Specification consistently describes the hinge bracket as secured to other sections of the frame (*i.e.* the bolster) rather than describing it as secured to the frame itself, which conveys to a POSITA that the hinge bracket is part of the frame, not a separate component. The Challenged Claims recite the “hinge bracket” in the same way. Rather than being introduced as a separate component between the “modular frame” and “swing legs,” it is introduced as the component *through which* each swing leg is coupled to the frame. *Id.* at Claim 1 (“A paving machine comprising: a modular frame; a plurality of swing legs, each swing leg coupled to a surface of the modular frame via a hinged bracket . . .”).

71. Because the claimed hinge bracket is part of the frame, an angular transducer located at the pivot connection between the frame and the swing leg (as disclosed in the ’723 Patent) must be “disposed on” either the frame or the swing leg for it to “measure an angular position between the swing leg and the modular frame,” as recited in Claim 1.

72. *Second*, even if the hinge bracket were not considered part of the frame, the Challenged Claims enjoy written description support because the term “disposed on” does not require that the angular position transducer be disposed *directly* on either the swing leg or modular frame, as Petitioner’s written

description argument implies. Pet. at 109. Notably, while Petitioner’s written description argument turns on this a very specific, very narrow understanding of the term “disposed on,” it declined to expressly construe the term in the Petition. Pet. at 108-111.

73. In view of the specification and other evidence, a POSITA would appreciate that the plain meaning of the phrase “disposed on” does not imply *direct* contact. I understand that Dr. Singhose agreed that he was “disposed on” his chair even though his clothing separated his body from the seat. Singhose Tr. II at 34:21-35:2; *see also* Ex. 2020 at 1574-75 (providing definitions of “on” that cover indirect contact).

74. For at least the foregoing reasons, it is my opinion that the term “disposed on” finds support in the ’723 Patent.

XII. IN MY OPINION, THE OBJECTIVE INDICIA OF NONOBVIOUSNESS CONFIRMS PATENTABILITY OVER THE CIII-RIO COMBINATIONS

A. The Objective Indicia Evidence is the Direct Result of the Unique Characteristics of the Claimed Invention, Practiced by G&Z’s Paving Machines

75. I have been informed that for objective indicia to carry any weight, there must be a nexus between the merits of the claimed invention and the objective evidence. This can be established by showing that the evidence is a

direct result of the unique characteristics of the claimed invention. In my opinion, the evidence discussed herein is directly tied to the claimed invention.

76. A POSITA would appreciate that the claimed invention is directed to the '723 Patent's on-the-fly embodiment with the recitation of, *inter alia*, a “slew gear drive . . . capable of steering the crawler track ***under load without lifting the crawler track***” and “the swing leg is configured to relocate the jacking column with the crawler track ***while moving and under load.***” '723 Patent at Claims 1, 6 (emphasis added); *see also* Ex. 1036 at 39-40 (the Board recognized that the “on-the-fly” embodiment is where the crawler track is rotated when in contact with the ground). In my opinion, G&Z's SmartLeg/AccuSteer technology is directly tied to the claimed on-the-fly embodiment.

77. As I discuss in detail below, there was at least a decade long need for a paving machine that can on-the-fly reposition the swing leg and crawler track when moving and under load, as the traditional paving machine had to be stopped and the crawler track raised off the ground for any repositioning (*see* Pet. at 16). The record evidence shows that this need was resolved by G&Z's introduction of paving machines, including the S600, that implement the claimed on-the-fly repositioning through the SmartLeg/AccuSteer technology:

The S600 is equipped with G&Z's new and patented AccuSteer: Slew Drive Track Control. The AccuSteer slew drives are mounted on top of the track yokes and are used to steer the tracks. The AccuSteer drives

are powered with hourglass worm technology to give long life, high accuracy and extremely high maneuverability

The S600 is also available with G&Z’s new and patented SmartLeg: Swing Leg System takes on the fly track line adjustments to the next level. Working in tandem with the AccuSteer system, The SmartLeg System allows the operator to adjust the swing leg angle on the fly while automatically keeping the track straight ahead. This offers a high level of flexibility for the contractor to maneuver around track line obstacles (e.g. fire hydrants, airport runway lights, etc.) on the fly and without stopping.

Ex. 2014 at 1-2 (emphases added); *see also* Ex. 2019 at 4. Accordingly, G&Z’s SmartLeg/AccuSteer technology enabled on-the-fly steering of the swing legs and crawler tracks when moving and under load and represented a significant improvement over traditional paving machines.

Other SmartLeg/AccuSteer evidence of objective indicia is also directly tied to the claimed on-the-fly features, including, *inter alia*, copying, industry praise, and commercial success. Accordingly, the objective indicia evidence is a direct result of the claimed invention’s unique on-the-fly characteristics.

B. G&Z’s SmartLeg/AccuSteer Technology Resolved a Decade Long Need For Repositioning the Swing Leg/Crawler Track When Moving and Under Load

78. After reviewing the evidence, it is my opinion that G&Z’s paving machines’ SmartLeg/AccuSteer technology solved the *at least* decade-long need

for a paving machine with swing legs and crawler tracks that could be repositioned when moving and under load.

79. The evidence shows that a need for on-the-fly swing leg/crawler track repositioning went unresolved for at least a decade until G&Z released its S600 paving machine with SmartLeg/AccuSteer technology in 2010. Ex. 2021 at 5-8 (G&Z Fall 2010 Newsletter announcing the “New S600 Multi-Purpose Slipform Paver”); ’723 Patent at (60) (provisional application filed March 2010). By at least the early 2000s, paving jobs transitioned from rural to urban, resulting in a need for a paving machine that could reposition its swing leg/crawler track when moving and under load to maneuver around obstacles as well as quickly relocate the swing legs/crawler tracks from one mode to another to get to the next jobsite, which is confirmed by industry experts in *Godbersen-Smith Construction Company, d/b/a GOMACO Corporation v. Guntert & Zimmerman Const. Div., Inc.*, IPR2020-01698 (“-01698 IPR”), Ex. 2022 (“Greenwood Decl.”) at ¶ 3 (explaining that a need was felt starting in the early 2000s); -01698 IPR, Ex. 2023 (“Holley Decl.”) at ¶¶ 4-6 (same). Conventional paving machines were incapable of such swing leg/crawler track repositioning when moving and under load because the machine had to be stopped and each swing leg/crawler track raised off the ground, which could easily take at least three hours. Greenwood Decl. at ¶ 4; Holley Decl. at ¶¶ 4-5.

80. Given the transition to urban paving and the drawbacks of the conventional paving machine, the industry required a paving machine that could: (1) reposition each swing leg and crawler track simultaneously while continuing to move in a paving direction; (2) transform from a paving mode to a transport mode while the swing leg/track is under load and moving; (3) enable a wide range of steering angles regardless of the angular orientation of the swing leg. See Greenwood Decl. at ¶ 4. I note that Mr. Greenwood, a seasoned veteran within the paving industry, articulated “a slipform company that could respond to the industry demands by introducing a slipform paver that can on-the-fly reposition its swing legs and quickly and easily relocate the crawler tracks to a 90 degree steering position so as to walk the slipform paver out of positions **would have a license a print money**. *Id.* at ¶ 7 (emphasis added).

81. G&Z’s S600 machine with SmartLeg/AccuSteer technology introduced “on the fly” swing leg/crawler track repositioning that provides for “high level of flexibility for the contractor to maneuver around track line obstacles (e.g. fire hydrants, airport runway lights, etc)” and the easy transformation of the paving machine from the paving mode to transport mode. Ex. 2014 at 1-2 (depicting SmartLeg/AccuSteer’s combination of swing leg adjustment, wide range of steering angles, and 90-degree steering for “on the fly” repositioning of the leg/track). Accordingly, the record evidence shows that the coordinated movement

of the swing leg/crawler track when moving and under load was introduced for the first time ever through G&Z’s SmartLeg/AccuSteer technology that met the industry’s demand and was praised by the paving industry who recognized the significant value of the technology. See Holley Decl. at ¶ 9 (explaining that G&Z’s SmartLeg/AccuSteer technology tremendously cut down “cost, labor, and setup”); Greenwood Decl. at ¶¶ 6-7 (explaining that G&Z’s “SmartLeg/AccuSteer technology was a revolutionary change to the conventional slipform paver” that “was a license to print money.”).

C. The S600’s Use of a Slew Drive for Driving And Steering Under Load Overcame Industry Skepticism

82. The record evidence also shows that due to the weight of the paving machines at issue and the forces required to reposition and maintain the crawler track when under load, those skilled in the art were skeptical of the use of a slew drive for repositioning the track when moving and under load.

83. I note that Kinematics, a motion control company that manufactures slew drives was skeptical of the use of a slew drive in a paving machine because

[REDACTED]

[REDACTED] Ex. 2007 (July 14, 2009 message email from the President of Kinematics Manufacturing Inc.). Even G&Z’s VP of Engineering expressed doubt in a slew drive design stating that he did not [REDACTED]

[REDACTED] Ex. 2024 at 4 (June 19, 2009 e-mail).

D. GOMACO and Other Competitors Copied G&Z’s SmartLeg/AccuSteer Technology

84. In my opinion, given the access to G&Z’s paving machines and the substantial similarity in pavers, GOMACO copied G&Z’s S600’s technology.

1. GOMACO, Among Other Competitors, Had Access to G&Z’s S600 Machine

85. I understand that following the release of the S600 with SmartLeg/AccuSteer technology, G&Z displayed the S600 at a trade show event (ConExpo 2011) that GOMACO attended. Ex. 2025 at 4 (describing that ConExpo 2011 G&Z displayed its S600 machine and a demonstrated the machine’s ability to navigate around obstacles and transform from paving mode to transport mode):



Ex. 2006 at ¶ 14 (depicting G&Z’s S600 at ConExpo 2011).

86. ConExpo bills itself as “the largest construction show in North America” and in 2011 it lived up to its hype. Ex. 2027. The 2011 ConExpo

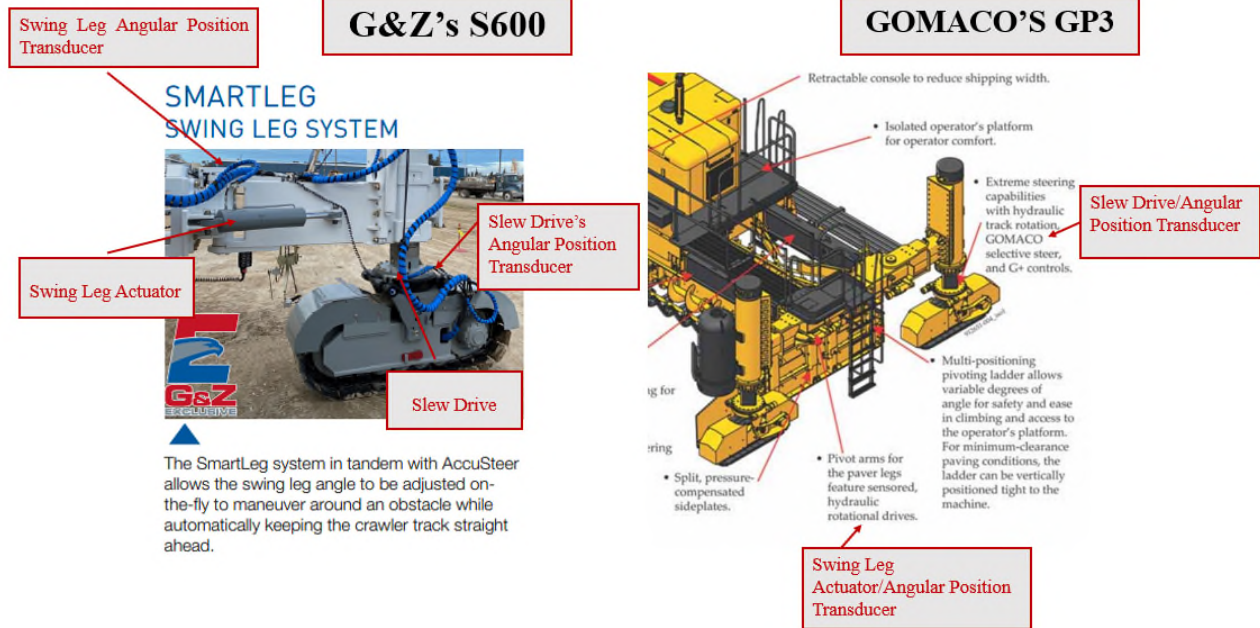
attracted nearly 120,000 attendees from all over the globe, 2,400 exhibitors, and held hundreds of industry meeting and educational seminars. Ex. 2026 at 1-2.

87. GOMACO was one of the attendees who had access to G&Z’s S600. Ex. 2028 at 2. Indeed, I understand that GOMACO’s VP of Engineering and R&D, [REDACTED]

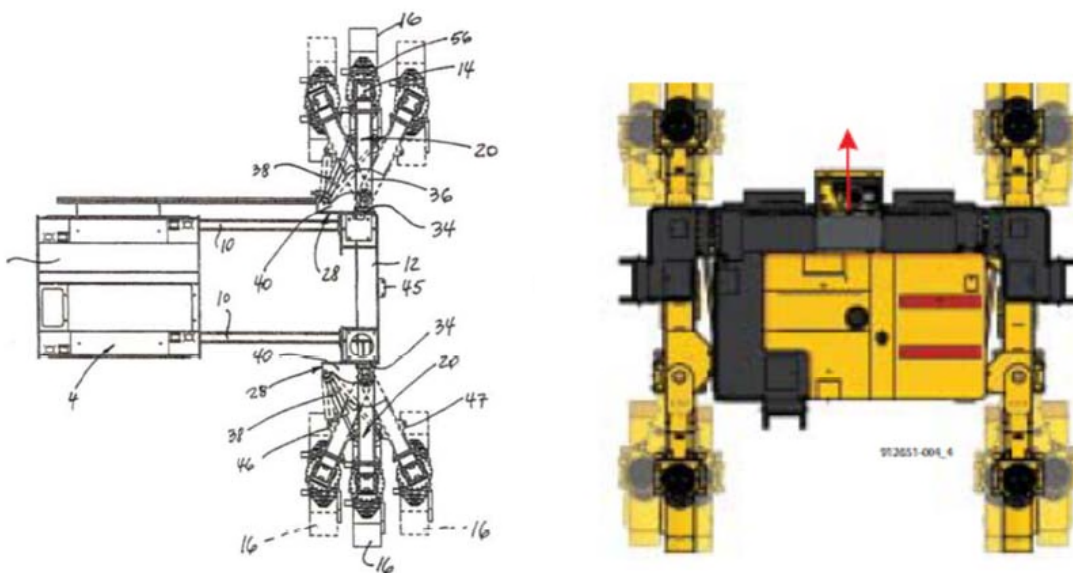
[REDACTED] Ex. 2010 at 18:17-20:24; *id.* at 16:20-18:3. Accordingly, GOMACO, among other competitors, had access to the design and functionality of G&Z’s S600’s SmartLeg/AccuSteer technology.

2. GOMACO’S Paving Machine is Substantial Similar to the S600 and its SmartLeg/AccuSteer Technology

88. The evidence demonstrates that GOMACO’ GP3 machine was the first of GOMACO’S pavers to include G&Z’s SmartLeg/AccuSteer technology—as it likewise used slew drives, angular position transducers, and a swing leg actuator to enable on-the fly repositioning. *See* Ex. 2029 at 3. The figures I have reproduced below show the substantial similarity between G&Z’s S600 SmartLeg/AccuSteer technology and that of GOMACO’s (including the use of a slew drive between the jacking column and crawler track):



Compare Ex. 2019 at 4 (annotated) with Ex. 2029 at 5 (annotated). Implementing G&Z's S600's SmartLeg/AccuSteer technology, GOMACO's GP3 machine (right), like the S600 machine (left), can reposition its swing leg/crawler track when moving and under load:



Compare ’723 Patent at Fig. 2 (The specification drawing depicting the S600 machine’s repositioning of the swing leg/crawler track when moving and under load) *with* Ex. 2029 at 4 (describing that the sensed leg and track pivot the leg/track to reposition when moving and under load). Significantly, GOMACO goes as far as to copy G&Z’s coined “SmartLeg” terminology with the introduction of GP3’s “**Smart Leg**”:

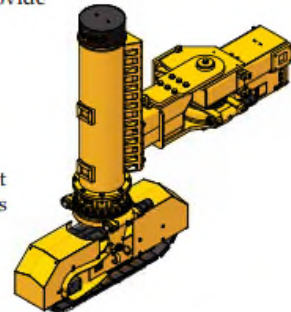
Smart Leg Positioning

Pivot arms for the paver legs feature sensed, hydraulic rotational drives. These Smart Pivots provide the G+ controls with information on the angle of rotation, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering.

Smart Track Steering

Track steering and rotation is accomplished with sensed, hydraulic rotational drives. This Smart Track Rotation provides the G+ controls with exact track location and position. Extreme steering is now possible with the tracks having the ability to steer farther than ever before.

Smart Leg Pivoting and Smart Track Rotation now lets the G+ system automatically control the direction and speed of each individual track as it travels through a radius.



Ex. 2029 at 3 (annotated). The Smart Leg Positioning/Smart Track Steering (G+ controls) also enables GP3 to, like the S600, transform from the paving mode to the transport mode “within minutes” without stopping the machine and lifting the track off the ground. Ex. 2029 at 3.

89. In my opinion, this is not a case of independent development because GOMACO failed to find a solution to the problem and implemented G&Z’s SmartLeg/AccuSteer technology instead, along with other competitors. GOMACO tried and failed where G&Z succeeded. In particular, wanting to achieve 90-degree steering for on-the-fly repositioning of the swing leg/crawler track,

GOMACO looked into whether a [REDACTED]
[REDACTED]. See Exs. 2011, 2012. I understand that after several years spent evaluating this option, GOMACO discovered [REDACTED]
[REDACTED] and shortly thereafter adopted G&Z’s claimed solution in its paving machines. Ex. 2012 at 1 (In May 2013, concluding that the [REDACTED]
[REDACTED]); Ex. 2030 at ¶ 23 (the Declaration of G&Z’s CEO, Ronald Guntert, submitted in the -01698 IPR establishing that GOMACO introduced its copycat GP3 in 2015). I also understand that G&Z’s other competitors, such as Wirtgen and Paving Powers, also implemented G&Z’s S600 SmartLeg/AccuSteer technology. See Ex. 2030 at ¶¶ 26-27 (showing that Wirtgen and Power Pavers also introduced copycat paving machines).

E. The Competitor’s Praised G&Z’s SmartLeg/AccuSteer Technology Through Copying While the Paving Industry in General Praised the Technology Through Recognition of its Significance

90. The evidence also shows that G&Z’s competitors and the paving industry praised G&Z’s SmartLeg/AccuSteer technology. As established above, GOMACO and other competitors copied the SmartLeg/AccuSteer technology, which those skilled in the art recognize is a form of praise and flattery.

91. In my opinion, the paving industry praised G&Z’s SmartLeg/AccuSteer technology through appreciation of its significance to the

industry. Indeed, the declarations from the fact witnesses (identified above) as well as articles from the paving industry recognized the significance and value of the SmartLeg/AccuSteer technology:

The AccuSteer system allows the operator to independently rotate the tracks almost a full circle, providing ***exceptional maneuverability on site*** and ***rapid swing leg relocation for paving and transport without the need to re-pin steering cylinders***.

Ex. 2014 at 1 (emphasis added).

Working in tandem with the AccuSteer system, the SmartLeg System allows the operator to adjust the swing leg angle on the fly while automatically keeping the track straight ahead. This ***offers a high level of flexibility*** for the contractor to maneuver around track line obstacles (e.g. fire hydrants, airport runway lights, etc.) ***on the fly and without stopping to make a bolster adjustment***.

Id. at 1-2 (emphasis added).

Using the combination of the ***90 degree steering mode and the SmartLeg feature***, the four swing bolsters and crawler tracks are automatically walked into the outboard, transport position in approximately 30 minutes. ***In this transport configuration, the S600 can easily walk and steer onto a standard 8 ft. wide trailer***. There is no switching of hoses required on the crawler tracks.

Ex. 2015 at 3 (emphasis added).

The S600 is equipped with G&Z’s AccuSteer: slew drive track control. The AccuSteer slew drives are mounted on top of the track yokes and are used to steer the tracks. The AccuSteer drives are powered with hourglass worm technology to give long life, high accuracy and high maneuverability. The hourglass worm engages multiple teeth on the pitch line of the ring gear from the hourglass thread. This engagement ***gives enormous strength and power*** to the gearbox. The AccuSteer system allows the operator to independently rotate the tracks almost a full circle, ***providing maneuverability on site and rapid swing leg relocation for paving and transport without the need to repin steering cylinders.***

Id. at 2 (emphasis added).

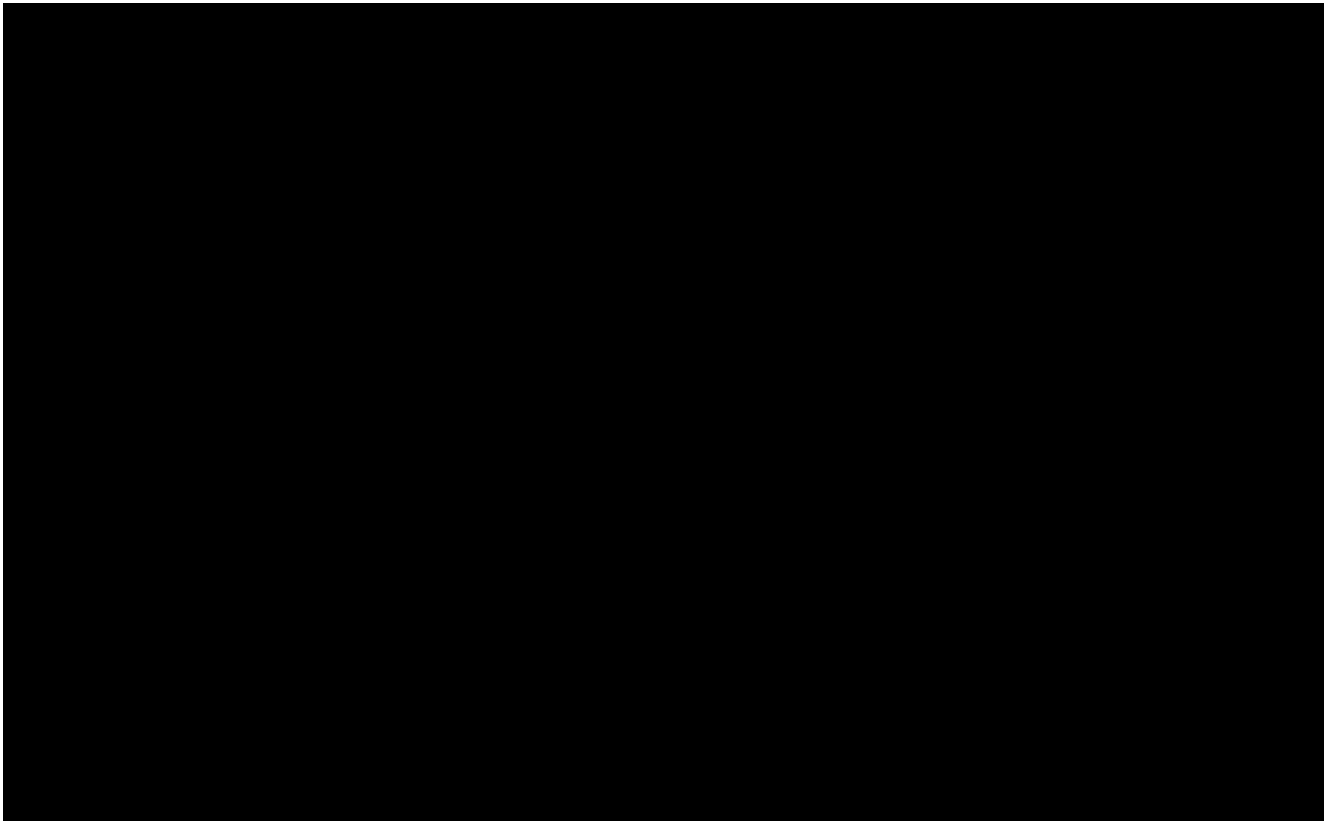
To ***optimize paver manoeuvrability*** at the site, Koss Construction equipped its S600 paver with G&Z’s available AccuSteer and SmartLeg systems. These allow the operator to ***manoeuvre the machine around track-line obstacles on the fly*** without having to stop for bolster swing-leg mechanical adjustment or steering transducer resetting.

Ex. 2016 at 4 (emphasis added).

92. Accordingly, in my opinion, these statements undeniably praise the SmartLeg/AccuSteer technology directly tied to the unique characteristics of the claimed invention’s on-the-fly features.

F. G&Z’s S600’s SmartLeg/AccuSteer Technology Drove the Commercial Success

93. I have reviewed several reports and an internal sales spreadsheet, all of which demonstrate that upon hitting the market, G&Z’s innovative S600’s SmartLeg/AccuSteer technology immediately began paying dividends, with the introduction of these features translating directly into commercial success in the form of significantly increased paving machine sales, driven by those designs equipped with the SmartLeg/AccuSteer technology:



Ex. 2031 (indicating the sales of G&Z’s paving machines with SmartLeg/AccuSteer technology (orange line) and without the technology (blue line)).

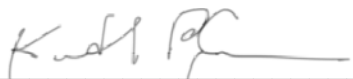
94. Once GOMACO entered the market with its copycat version of G&Z’s SmartLeg / AccuSteer equipped paving machines, the GP3, G&Z’s market share quickly eroded, with G&Z [REDACTED] of its market share between 2014 and 2019 while GOMACO’s market share [REDACTED] Ex. 2035 at 13; Ex. 2036 at 10. GOMACO introduced its GP3 paver in 2015. Ex. 2030 at ¶ 23.

95. In view of the foregoing, it is my opinion that the the objective indicia of nonobviousness confirms the patentability of the Challenged Claims over the CIII-Rio combination.

XIII. CONCLUSION

96. In conclusion, based on my experience and expertise, it is my opinion that the Challenged Claims are patentable over the CIII-Rio combination.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code. Executed on February 26, 2025, in Ames, Iowa.



Dr. Kenneth “Mark” Bryden

APPENDIX A

Kenneth “Mark” Bryden

Education

University of Wisconsin–Madison; PhD, Mechanical Engineering, 1998

University of Wisconsin–Madison; MS, Mechanical Engineering, 1993

Idaho State University; BS, General Engineering with high honors, 1977

Academic Positions Held

2015–present Professor (with tenure), Iowa State University

2004–2015 Associate Professor (with tenure), Iowa State University

2006–2007 Interim Chair, Department of Mechanical Engineering, Iowa State University

2005–2006 Associate Chair, Department of Mechanical Engineering, Iowa State University

2004–2012 Program Chair, Complex Adaptive Systems, Iowa State University

1998–2004 Assistant Professor, Iowa State University

1995–1997 Teaching Assistant, University of Wisconsin–Madison

1991–1998 Graduate Fellow, University of Wisconsin–Madison

Other Professional Employment

2006–present Program Director; Decision Science; US Dept of Energy, Ames National Laboratory
Founding director of the Ames National Laboratory Decision Science program. The Ames National Laboratory is a US Dept of Energy National Laboratory (FFRDC) managed under contract by Iowa State University. Decision Science is one of five programs/ divisions/centers within the Ames National Laboratory.

1989–1991 Manager, Radiological Controls Engineering, Westinghouse Electric Corp.
I managed all radiological controls engineering for three nuclear power plants and one hot fuel cutting and management facility.

1987–1989 Shift Test Manager, A1W Plant, Westinghouse Electric Corp.
Responsible for all on-shift testing during a multiyear refueling and maintenance period for a dual reactor power plant.

1986–1987 Assistant Manager, Operations, A1W Plant, Westinghouse Electric Corp.
Managed day-to-day operations for a dual reactor power plant.

1984–1986 Manager, Long Range Planning and Engineering, Westinghouse Electric Corp.
Planned, proposed, and performed the engineering required for refueling and extended maintenance periods for three nuclear power plants.

1982–1984 Manager, Prototype Programs, Westinghouse Electric Corp.
Programmatic responsibility for three nuclear power plants.

1981–1982 Shift Supervisor, A1W Plant, Westinghouse Electric Corp.

1977–1981 Nuclear Plant Engineer, A1W Plant, Westinghouse Electric Corp.

Honors and Awards

- 2020 Faculty-Staff Inspiration Award, Iowa State University Alumni Association, 2020
- 2013 Melville Medal, American Society of Mechanical Engineers, 2013.
“The Melville Medal was first awarded in 1927 and is the highest honor for the best original technical paper published in the *ASME Transactions* in the past two years.”
- Best Scientific Paper, 2013 International Symposium on Environmental Software Systems, 2013.
- 2012 Regional Excellence in Technology Transfer, for “Virtual Paint,” National Federal Laboratory Consortium, 2012.
- Terrestrial Energy Systems Best Paper Award, AIAA 50th Aerospace Sciences Meeting, 2012.
- AIAA Associate Fellow, 2011.
- R&D 100 Award, for “osgBullet,” Top 100 Research Developments of 2010, R&D Magazine, 2010.
“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention,’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”
- 2010 National Excellence in Technology Transfer, for “Virtual Engineering – Process Simulator Interface,” National Federal Laboratory Consortium, 2010.
The Federal Laboratory Consortium’s Excellence in Technology Transfer Award honors work that brings technologies from labs to the marketplace through collaboration with industry, academia, or other labs.
- Best Paper, 19th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2009), 2009.
- R&D 100 Award, for “Virtual Engineering – Process Simulator Interface,” Top 100 Research Developments of 2009, R&D Magazine, 2009.
“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”
- 2009 Regional Excellence in Technology Transfer, for “Virtual Engineering – Process Simulator Interface,” National Federal Laboratory Consortium, 2009.
- VEISHA Professor, VEISHA student committee, 2009.
- Best Paper, 18th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2008), 2008.
- Center for Excellence in the Arts and Humanities Fellow, ISU Center for Excellence in the Arts, 2007.
- Best Paper, 17th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2007), 2007.

- R&D 100 Award, for “Texture-based Engineering Tools,” Research and Development Magazine, 2006.

“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”

- Margaret Ellen White Graduate Faculty Award, ISU, 2006.
Recognizes a member of the graduate faculty who has demonstrated exceptional mentorship to graduate students both during their time at Iowa State and beyond graduation
- Miller Faculty Fellow, Center for Teaching Excellence, ISU, 2004–2006.
- 2004 Information and Electrical Technologies Select Paper Award, 2004 American Society of Agricultural Engineers International Meeting, 2004.
- Superior Engineering Teacher, College of Engineering, ISU, 2004.
- First Place Award, Evolutionary Art, “Computer Generated Evolutionary Music,” 2004 Congress on Evolutionary Computation (CEC2004), 2004.
- E-Week Outstanding Mechanical Engineering Professor, 2003.
- Most Effective Instructor Award, ISU Academic Success Center, 2003.
- Sigma Xi, 2003.
- Leadership through Engineering Academic Diversity Faculty Involvement Award, ISU LEAD program, 1999-2001.
- Outstanding Mechanical Engineering Faculty Member Award, ISU ASME Student Chapter, 2000.
- Pi Tau Sigma Mechanical Engineering Department Outstanding Teaching Assistant Award, University of Wisconsin–Madison, 1997.
- Power Engineering Education Foundation Fellowship, Edison Electric Institute, 1993–1997.
- E. B. Fred Fellowship, University of Wisconsin–Madison, 1992–1993.
- Arthur West Mechanical Engineering Department Award, University of Wisconsin–Madison, 1991–1992.
- Wisconsin Alumni Research Foundation Fellowship, University of Wisconsin–Madison, 1991-1992.
- Graduation with High Honors, Idaho State University, 1977.
- Alpha Mu Gamma, 1976.
- Phi Kappa Phi, 1976.
- President’s Outstanding Achievement Award, Idaho State University, 1975.

Patents

1. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, Canadian Patent No. 2,771,839, February 9, 2016.
2. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, Chinese Patent No. 200980113857, November 2015.
3. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, US Patent No. 8,839,621, September 23, 2014.
4. “Creating Realtime Data-Driven Music Using Context Sensitive Grammars and Fractal Algorithms,” K. M. Bryden, K. A. Bryden, and D. A. Ashlock, US Patent No. 7,304,228, December 4, 2007.

Startups founded

1. AgSolver Inc.— Co-Founder and Board Chair, AgSolver Inc., 2013–2017

AgSolver is an agronomic decision services company whose products are focused on improving land management decisions, simplifying mandatory compliance and reporting activities, and maximizing returns for agricultural land investments. AgSolver was founded in 2013 based on technology developed in my research group. Agsolver was acquired in 2017 by EFC Systems.

2. Praxik LLC — Co-Founder and Board Chair, Praxik LLC, 2014–2018

Praxik is a software services company focused on visually based decision-making tools for industry. Founded in 2014 based on technology developed in my research group, Praxik was acquired in 2018 by TCompanies Inc.

Nonprofits founded

- Engineers in Technical and Humanitarian Opportunities for Service (ETHOS)

Founder, President, and Board Chair, 2002–2015; Board Member, 2015–2020

ETHOS is a non-profit focused on addressing the energy needs of the poor in the developing world. The annual ETHOS conference unites the cookstoves and clean cooking community by bringing together lab and field based scientific knowledge that fosters collaborations, elevates scientific rigor, and disseminates knowledge to manufacturers and designers, leading to development and greater adoption of cleaner stoves.

Professional Service

Editorial Service

- *International Journal of Energy for a Clean Environment*, Editorial Board Member, 2019–present
- *Development Engineering*, Associate Editor, 2015–2023
- *Journal of Engineering for Gas Turbines and Power*, Associate Editor, 2004–2007
- *Energy for Sustainable Development, Special Issue: Cookstoves in Developing Nations*, Guest Editor, March 2005

Service to Professional Societies

- AIAA, AIAA Committee on Standards for CFD, Committee Member, 2003–present
- ASME, Percy Nichols Award Committee, Member at Large, 2019–2023
- ASME, Percy Nicholls Award Committee, Chair, 2010–2020
- AIAA, AIAA Technical Committee on Terrestrial Energy Systems, Committee Member, 2008–2022
- AIAA, AIAA Technical Committee on Meshing, Visualization, and Computational Environments, Committee Member, 2009–2018
- ASME, James Harry Potter Gold Medal Committee, Committee Member, 2010–2016
- AIAA, AIAA Green Engineering Program Committee, Committee Member 2013–2019
- AIAA Technical Committee on Terrestrial Energy Systems, Chair, 2012–2015
- ASME, Power Division, Honors and Awards Committee, Vice Chair, 2013–2014
- AIAA, AIAA Technical Committee on Terrestrial Energy Systems, Deputy Chair, 2010–2012
- ASME, Committee on Academic & Industrial Research, Chair, 2008–2009
- ASME, Fuels and Combustion Technology Division, Executive Committee, Vice Chair, 2004–2005
- ASME, ASME Energy Institute Formation ad hoc Committee, Committee Member, 2003–2005
- ASME, Fuels and Combustion Technology Division, Executive Committee, Program Chair, 2003–2004
- ASME, Power Division Executive Committee, Chair, 2002–2003
- ASME, Fuels and Combustion Technology Division, Committee on Academic & Industrial Research, Chair, 2002–2003
- ASME, Fuels and Combustion Technology Division, Executive Committee, Chair of Administrative Committees, 2002–2003

Government and Educational Committees

- Member, DOE “5G for Science Working Group” and member of the organizing committee for the 5G Enabled Energy Innovation Workshop, 2019 – 2021.
This resulted in the “5G-Enabled Energy Innovation: Advanced Wireless Networks for Science Workshop Report” available at <https://www.osti.gov/servlets/purl/1606539>, 2019–2021
- Member, Advisory Board, Center for Advanced Modeling and Simulation, Idaho National Laboratory, US Department of Energy, 2004-2010
- Member, Advisory Board, Institute for People Centered Computation, Bristol, UK, 2006–2009

Other Professional Service

- Official Nominator, VinFuture Prize, 2023–present
- Member, ANSI sponsored US Technical Advisory Group to ISO/TC 285: Clean cookstoves and their clean cooking solutions, 2012–present
- Member, Global Alliance for Clean Cookstoves, Fuels and Technology Committee, 2011–present

- Board Member, Engineers in Technical and Humanitarian Opportunities for Service (ETHOS), 2015–2020
- Founder, President, and Board Chair, Engineers in Technical and Humanitarian Opportunities for Service (ETHOS), 2002–2015
- Lead author, the World Health Organization development of the *WHO Indoor Air Quality Guidelines: Household Fuel Combustion – Review 10: Burns and Poisoning*, 2012–2014
- Board Member, Board of Directors, Medicine for Mali, 2007–2010

Books authored

1. *Combustion Engineering*, 3rd Ed., K. M. Bryden, K. W. Ragland, S.-C. Kong, Francis Taylor, 2022.
2. *Combustion Engineering*, 2nd Ed., K. W. Ragland, K. M. Bryden, Francis Taylor, 2011.

Selected Peer-Reviewed Articles

Professor Bryden has published more than 250 peer-reviewed articles on wide range of technical topics including power systems, computational and systems modeling, heat transfer and fluid mechanics, engineering design, humanitarian engineering, and applied mathematics. The 34 articles/chapters presented here represent his current work and/or most cited papers.

1. W. Kim, T. I-P. Shih, R. Dalton, K. M. Bryden, S. Y. Chang, G. S. Park, “Flow and Heat Transfer in a Ribbed Converging-Diverging U-Duct Under Rotating and Non-Rotating Conditions,” *J. of Turbomachinery* 147(3): 031005 (2025).
2. S. Ferguson, L. Retzlaff, K. A. Bryden, K. M. Bryden, “Narrative Drives Design Decision Making,” *Proceedings of the Design Society: 18th International Design Conference*, pp 965-974 (2024).
3. K. M. Bryden, “Designing a Sustainable Peace: Narrative Building and the Need for Transparency in Public Modeling,” Chapter 11 in *Building Positive Peace* eds C. Campbell and S. Cordery, Cambridge Scholars Publishing, (2023).
4. S. Nketia, K. Bryden, R. Dalton, T. I-P. Shih, “Large Eddy Simulation of Externally Induced Ingress about an Axial Seal by Stator Vanes,” *Energies* 16(16):5985 (2023).
5. C.-S. Lee, T. I.-P. Shih, K. M. Bryden, R. P. Dalton, R. A. Dennis, “Strongly Heated Turbulent Flow in a Channel with Pin Fins,” *Energies*, 16(3):1215 (2023).
6. P. Pezzini, K. M. Bryden, P. Finzell, D. Tucker, “A Novel Multi-Agent Resource Sharing Algorithm for Control of Advanced Energy Systems,” *Industrial & Engineering Chemistry Research*, 60(30):11171-11186 (2021).
7. S. Hipple, H. Bonilla-Alvarado, P. Pezzini, L. Shadle, K. M. Bryden, “Using Machine Learning Tools to Predict Compressor Stall,” *J. of Energy Resources Technology*, 142(7):072305 (2020).
8. K. C. Cruz, P. Pezzini, L. J. Shadle, K. M. Bryden, “Surge and Stall Detection Using Acoustic Analysis for Gas Turbine Hybrid Cycles,” *J. of Engineering for Gas Turbines and Power*, 142(4):041026 (2020).
9. H. Bonilla-Alvarado, K. M. Bryden, L. Shadle, D. Tucker, P. Pezzini, “Development of Realtime System Identification to Detect Abnormal Operations in a Gas Turbine Cycle,” *J. of Energy Resources Technology*, 142(7):070906 (2020).
10. A. Tsai, D. Tucker, P. Pezzini, K. M. Bryden, “Multiple-Model Adaptive Control of a Hybrid Solid Oxide Fuel Cell Gas Turbine Power Plant Simulator,” *J. of Electrochemical Energy Conversion and Storage*, 16(3):031003-031003-11 (2019).

11. D. Oryshchyn, N. F. Harun, D. Tucker, K. Bryden, L. Shadle “Fuel Utilization Effects on System Efficiency in Solid Oxide Fuel Cell Gas Turbine Hybrid Systems,” *Applied Energy*, 228:1953-1965 (2018).
12. P. Pezzini, K. M. Bryden, and D. Tucker, “Multi-coordination Control Strategy Performance in Hybrid Power Systems,” *J. of Electrochemical Energy and Storage*, 15:031007-1–15 (2018).
13. P. Stevenson, C. A. Mattson, K. Bryden, N. A. MacCarty, “Towards a Universal Social Impact Metric for Engineered Products that Alleviate Poverty,” *J. of Mechanical Design*, 140(4)041401-1–10 (2018).
14. N. A. MacCarty, K. M. Bryden, “Costs and Impacts of Potential Energy Strategies for Rural Households in Developing Communities,” *Energy*, 138:1157–1174 (2017).
15. P. Finzell and K. M. Bryden, “A Novel Resource Sharing Algorithm Based on Distributed Construction for Radiant Enclosure Problems,” *Advances in Engineering Software*, 108:57–67 (2017).
16. C-S Lee, T. I-P Shih, and K. M. Bryden, “Effects of Averaging the Heat Transfer Coefficient on Predicted Material Temperature and Its Gradient,” *J. of Heat Transfer*, 139:022002-1–14 (2017).
17. N. A. MacCarty, K. M. Bryden, “An Integrated Systems Model for Energy Services in Rural Developing Communities,” *Energy*, 113:536–557 (2016).
18. C-S Lee, T. I-P Shih, K. M. Bryden, “Estimating Over Temperature and Its Duration in a Flat Plate with Sudden Changes in Heating and Cooling,” *J. of Turbomachinery*, 138(6):061007-1–12 (2016).
19. P. E. Antonelli, K. M. Bryden, R. LeSar, “A Model-to-Model Interface for Concurrent Multiscale Simulations,” *Computational Materials Science*, 123:244–251 (2016) **[Editors Choice]**.
20. N. A. MacCarty, K. M. Bryden, “A Generalized Heat-Transfer Model for Shielded-Fire Household Cookstoves,” *Energy for Sustainable Development*, 33:96–107 (2016).
21. N. A. MacCarty, K. M. Bryden, “A Unified Set of Experimental Data for Cylindrical, Natural Draft, Shielded, Wood-Fired Cookstoves,” *Energy for Sustainable Development*, 26:62–71 (2015).
22. N. A. MacCarty, K. M. Bryden, “Modeling of Household Biomass Cookstoves: A Review,” *Energy for Sustainable Development*, 26:1–13 (2015).
23. N. G. Johnson, K. M. Bryden, “Field-based Safety Guidelines for Solid Fuel Household Cookstoves in Developing Countries,” *Energy for Sustainable Development*, 25:56–66 (2015).
24. S. T. Diekman, D. Pope, H. Falk, M. F. Ballesteros, M. Dherani, N. Johnson, K.M. Bryden, N. Bruce, M. Peck, “Review 10: Burns and Poisoning,” *WHO Indoor Air Quality Guidelines: Household Fuel Combustion*, ed. N. Bruce, World Health Organization (2014).
25. D. J. Muth Jr, K. M. Bryden, “An Integrated Model for Assessment of Sustainable Agricultural Residue Removal Limits for Bioenergy Systems,” *Environmental Modelling & Software*, 39:50–69 (2013).
26. N. G. Johnson K. M. Bryden, “Factors Affecting Fuelwood Consumption in Household Cookstoves in an Isolated Rural West African Village,” *Energy*, 46:310–321 (2012).
27. A. E. E. Khalil, A. K. Gupta, K. M. Bryden, S. C. Lee, “Mixture Preparation Effects on Distributed Combustion for Gas Turbine Applications,” *J. of Energy Resources Technology*, 134(3):032201 (2012). **[Awarded the ASME 2013 Melville Medal]**
28. N. G. Johnson and K. M. Bryden, “Energy Supply and Use in a Rural West African Village,” *Energy*, 43:283–292 (2012).
29. D. J. Muth Jr., D. S. McCorkle, J. B. Koch⁺, and K. M. Bryden, “Modeling Sustainable Agricultural Residue Removal at the Subfield Scale,” *Agronomy Journal*, 104(4):970–981 (2012).
30. A. C. Velivelli, K. M. Bryden, “Initial Formulation of an Optimization Method Based on Stigmergic Construction,” *International Journal of Agent Technologies and Systems*, 3(4):19–36 (2011).

31. K. M. Bryden and M. J. Hagge, “Modeling the Combined Impact of Moisture and Char Shrinkage on the Pyrolysis of a Biomass Particle,” *Fuel*, 82(13):1633–1644 (2003).
32. M. J. Hagge, K. M. Bryden, “Modeling the Impact of Shrinkage on the Pyrolysis of Dry Biomass,” *Chemical Engineering Science*, 57(14):2811–2823 (2002).
33. K. M. Bryden, K. W. Ragland, C. J. Rutland, “Modeling Thermally Thick Pyrolysis of Wood,” *Biomass and Bioenergy*, 22(1):41–53 (2002).
34. K. M. Bryden, K. W. Ragland, “Numerical Modeling of a Deep, Fixed Bed Combustor,” *Energy & Fuels*, 10(2):269–275 (1996).