IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Title:	AUTOMATIC GRADER STABILIZER

DECLARATION OF DR. JAMES GLANCEY, PH.D., P.E.

DEERE & COMPANY-1003

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LISTING OF CHALLENGED CLAIMS

Claim 1	
[1.pre]	A method for controlling a dozer blade controlled by an automatic grade control system on a skid steer vehicle comprising:
[1.a]	providing a skid steer vehicle having a main arm with a front side operably coupled to a dozer blade assembly;
[1.b]	providing a stop connected to the skid steer vehicle upon which a point of the main arm rests thereby defining a lower limit of movement of the main arm;
[1.c]	positioning the point of the main arm against the stop;
[1.d]	preventing the ability of the main arm from providing any lifting force by restricting the ability of a hydraulic that lifts the main arm;
[1.e]	operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface.

Claim 2	
[2.pre]	The method for controlling a dozer blade as in claim 1 further including:
[2]	locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

Claim 3	
[3.pre]	The method for controlling a dozer blade as in claim 1 further including:

[3.a]	operating a valve to hydraulically isolate the hydraulic lift that lifts the main arm to further prevent any movement of the main arm.

Claim 4	
[4.pre]	The method for controlling a dozer blade as in claim 3 further including:
[4.a]	locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

I, Dr. James Glancey, Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. I have been retained as a technical expert by counsel on behalf of Deere & Company ("Petitioner"). I understand that Petitioner is requesting that the Patent Trial and Appeal Board institute an *inter partes* review ("IPR") proceeding with respect to U.S. Patent No. 10,533,300 ("the '300 patent") (EX1001).

2. I have been asked to provide my independent analysis of the '300 patent in light of certain prior art publications, and I have done so based on my personal knowledge and experience.

3. I am not, and never have been, an employee of Deere & Company. I received no compensation for this Declaration beyond my normal hourly compensation based on my time actually spent analyzing the '300 patent, the prior art publications cited below, and various issues related thereto. I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the '300 patent.

II. QUALIFICATIONS

4. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field. My education and experience are described more fully in the attached curriculum vitae (Appendix A). For ease of reference, I have highlighted certain information below.

5. I grew up on a dairy and grain farm in New Jersey, where, in addition to high moisture corn, corn silage, alfalfa haylage and alfalfa hay, several grain crops were grown including corn (for grain), soybeans, wheat, barley, rye and oats. My formal education consists of a Bachelor of Science in Agricultural Engineering from the University of Delaware; a Master of Science in Agricultural and Biological Engineering from the University of California, Davis; and a Doctor of Philosophy in Engineering with an emphasis in Mechanical Engineering and concentrations in Civil Engineering, Agricultural and Biological Engineering, and Applied Mathematics from the University of California, Davis.

6. After completing graduate school and accepting an engineering faculty position at the University of Delaware, I began operating my family's farm, owning and raising lean beef cattle breeds and growing grain crops on about 160 acres for about 10 years. Equipment at the farm included a front end loader, farm tractors, road tractors and trailers, a dump truck, and various tillage equipment.

7. In 2016, I purchased my own farm in Middletown, Delaware where corn and soybeans are grown, as well as several vegetables. I own several pieces of machinery including a skid loader with various attachments, agricultural tractors, trucks, trailers and tillage and grading equipment. Our farm also has a full wood shop, and metal fabrication and repair shop including fabrication machinery.

8. My academic experience includes serving as an Associate Professor and now Full Professor of Machine Design and Development in Mechanical Engineering at the University of Delaware. In addition, I currently hold an appointment in the College of Agriculture and Natural Resources as a Full Professor and the Delaware Cooperative Extension as an Engineering Specialist. In this capacity, I provide a variety of services using my technical knowledge and design expertise. Several examples include detailed engineering designs and/or redesigns for on-farm projects including fluid power systems for mobile and processing equipment, grain handling and drying, grain and vegetable harvesting, planting and tillage and detailed engineering support for other on-farm topics including, but not limited to, animal housing, nutrient management, fresh market fruit and vegetable processing and handling, and treated wastewater disposal and reuse. My research has included development and improvements for agricultural and construction equipment including skid-steer loaders with Case-New Holland, Inc., and fly-by-wire propulsion systems for mobile equipment, also with Case-New Holland, Inc.

9. As a Full Professor in the Mechanical Engineering Department, my responsibilities including teaching, research, outreach, and consulting for various industries and litigation matters. I currently teach or have taught each of the upper-level Mechanical and Machine Design Courses in the Department of Mechanical Engineering, as well as co-teach the Capstone Design Course that annually serves

over 200 students in Mechanical Engineering, Biomedical Engineering, Civil Engineering, Environmental Engineering, and Electrical Engineering. In this capacity, I introduce students to the disciplines of design science, product and process development, design for manufacture, and failure analysis. I also lead the Graduate Level Industry Partnership Program in Mechanical Engineering, which facilitates industry-sponsored design and modeling projects for graduate students to pursue for academic credit. These courses use industry-sponsored design projects and have served various design needs for over 200 companies in the United States.

10. I have also taught courses on the design of agricultural machines and mechanisms, and on fluid power systems and logic. The fluid power systems course included both design theory and modeling, as well as a laboratory component of the course where students built and tested both hydraulic and pneumatic power systems.

11. I currently hold an appointment in the University of Delaware Center for Composite Materials, an internationally recognized, interdisciplinary center of excellence for composites research and education. My work in composites is threefold: 1) automation of VARTM (Vacuum Assisted Resin Transfer Molding) infusion processes, 2) new product development using composite materials, and 3)

rapid preform formation for near net shape structural components for automotive applications.

12. I currently hold an appointment in the University of Delaware Center for BioMechanical Engineering Research, a nationally recognized, interdisciplinary center of excellence for biomechanics and biomedical research and education. My work in biomechanics and biomedical design is twofold: 1) new hand and power tool designs to reduce vibration generation and transmission to the human body, and 2) in-garment soft robotics to assist manufacturing workers and the disabled with basic repetitive-motion motor skills.

13. I serve as the academic liaison for the two College of Engineering Machine Shops, where I am responsible for coordinating the academic needs for the shops and working with the master machinists for scheduling to meet both academic and research needs. The Student Machine Shop currently trains and hosts over 600 undergraduate and graduate students annually, representing most majors within the College of Engineering at the University of Delaware.

14. Based on my research at the University of Delaware, I am an inventor on one U.S. patent related to hydraulically powered harvesting equipment and three U.S. patents related to composite material manufacturing and automation. I have also applied for six provisional patents and have several patent applications currently under review in the U.S. Patent and Trademark Office.

15. Additionally, my research and product design work has led to commercialized products. For example, based on my product design and research and development work in composites, the HardCap™ hand-struck safety tool line was commercialized and is being sold throughout the world by several large distributors including Home Depot and Amazon. *See*, *e.g.*,

- https://www.amazon.ca/Mayhew-66901-Hard-Punch-4-Piece/dp/B000OQ21AM (accessed on May 29, 2024)
- https://www.grainger.com/product/MAYHEW-Hardcap-Cold-Chisel-Steel-6DKF2 (accessed on May 29, 2024)

16. Since 1997, I have been a Registered Professional Engineer (Mechanical) in the State of Delaware (active) and the State of Maryland (currently inactive).

17. I have 28 years of engineering experience as a registered professional engineer and engineering design consultant. I am currently the owner and principal of Mechanical Design and Forensic Analysis LLC of Middletown, DE. I was also a partner of Structural Mechanics Associates of Haverford, PA until the founder and principal owner retired. I have been recognized as a mechanical engineering expert witness in state or federal courts (or both) in California, Colorado, Delaware, Illinois, Iowa, Florida, Michigan, Nevada, New Jersey, New York, Ohio, Pennsylvania, South Carolina, Texas, Utah, Virginia, and St. Croix, Virgin Islands.

In my practice, I regularly consult for companies and law firms to assist them with various types of mechanical design and manufacturing challenges and litigation matters for products ranging from medical devices and manufacturing processes to consumer products to industrial and farm machinery.

18. I have been hired as an engineering design consultant for multiple major U.S. companies and government agencies including: Monsanto (2x), the DuPont Company, Wilmington, Delaware (3x), Advance Materials Technologies, Wilmington, Delaware, Siemens Healthcare Diagnostics, Newark, Delaware (9x), Northrup Grumman (formerly ATK/Thiokol), Elkton, Maryland, Kraft Foods, Dover, Delaware (3x), the State of Delaware (3x), the Town of Middletown, Delaware (6x), the Town of Odessa, Delaware, the Town of Bridgeville, Delaware, Baltimore Tool Works, Inc. (2x), Duffield Engineering Associates, Wilmington, Delaware, the Consumer Union (Consumer Reports Magazine), Yonkers, New York (3x), and Dogfish Head Brewery, Milton, Delaware.

19. My professional academic accomplishments include over 50 refereed engineering journal articles and refereed proceedings. I served for eight years as Associate Editor for the two premier engineering journals in the U.S. for agriculture and food production: *Transactions of the American Society of Agricultural Engineers* and *Applied Engineering in Agriculture*. I have also published over 75 conference papers and given 190 invited and/or conference presentations in the U.S.

and Europe. These publications included the modeling and simulation of hydraulic systems and the development and testing of bio-based hydraulic fluids using genetically enhanced soybean oil and a novel low volume testing stand for these biological fluids.

20. I have received several academic awards as well as awards from industry since being promoted to Associate and then Full Professor at Delaware. This includes being inducted into the University of Delaware's Mentor's Circle in 2001, which is an award given to faculty who have been nominated by students and faculty for their accomplishments in mentoring, teaching, and advising undergraduate and graduate students. I also received the George M. Worrilow Award, the highest honor awarded by the College of Agriculture and Natural Resource, given to an alumnus of the University of Delaware who has demonstrated outstanding service to agriculture. In 2014, I received the Delaware Farm Bureau Distinguished Service to Agriculture Award, given to recognize significant contributions to agriculture in the mid-Atlantic region; I was the first faculty member at the University of Delaware to ever win this award. In 2012, I, along with Delaware Governor Jack Markell, Secretary of Environmental Control for the state of Delaware Collin O'Mara; Secretary of Agriculture for the State of Delaware Edwin Kee; Mayor of Middletown, Delaware, Kenneth Branner; and President of Artesian Water, Dian Taylor, received the Water Resources Association

of the Delaware River Basin's Government Award for the first use of highly treated municipal wastewater for irrigating agricultural crops on an as-need basis in the mid-Atlantic region.

21. As a reviewer of peer-reviewed journal articles being considered for publication, I received the American Society of Agricultural and Biological Engineers Outstanding Reviewer award in 2012. I was also nominated and selected to serve two four-year terms as Associate Editor for the two journals published by the American Society of Agricultural and Biological Engineers. I have also served as a peer reviewer for 20 different journals and other publications including researchwork in Mechanical and Agricultural Engineering, Composite Materials, and Agricultural Production and Science.

22. As part of my work as a faculty member at the University of Delaware, I have conducted multiple projects specifically related to engineering for agriculture.

23. I have been the principal investigator for 17 farm machinery research construction equipment projects with Case-New Holland, Inc. and CNH Industrial, Inc. in New Holland, PA. These engineering research and development projects included several aspects of the design of CNH skid-steer loaders including, but not limited to, the propulsion system, propulsion control systems, and heat rejection (cooling) systems of the engine system and the hydraulic system. I have also been principal investigator on two projects with FMC Corporation in Hoopston, IL on

the mechanical harvest of processed vegetables using hydraulically driven machinery. I have also conducted several research and engineering projects on a variety of agricultural issues with various agricultural food and grain processors including Vlasic Foods, B&G Foods, Kraft Foods, Kenny Produce, Hanover Foods, Dogfish Head Brewery, the Delaware Refining Company, and the Puglisi Egg Farms of Delaware, Inc.

24. Through the Delaware Cooperative Extension Service, I have cooperated with and provided engineering services and guidance to farmers on over 50 on-farm engineering projects in Delaware, Maryland, Pennsylvania, and New Jersey. Topics have included but are not limited to fluid power systems and hydraulics, grain handling, animal housing and ventilation, feeding, waste disposal, machinery design, and harvesting of a variety of grain and specialty crops. In this capacity and as outlined in my Curriculum Vitae, I have made over 70 invited presentations at Cooperative Extension Service meetings or other local farming conferences and meetings. *See* Appendix A.

25. As explained above, I have a Doctor of Philosophy in Engineering with an emphasis in Mechanical Engineering and concentrations in Civil Engineering, Agricultural and Biological Engineering, and Applied Mathematics and many years of experience in these technical fields. Specifically, I have extensive experience in operating and researching vehicles including skid-steer

loaders for agricultural and other uses. I have experience working with and teaching about fluid power system design and analysis, including teaching a laboratory class component related to building and testing hydraulic and pneumatic power systems, and experience in mechanical design resulting in multiple patents related to hydraulically powered agricultural/worksite equipment. The technology described in the '300 patent relies on knowledge of agricultural/work vehicles (in particular skid-steers), hydraulic fluid control, and mechanical design. Because I have significant experience in all three of these technical areas, I believe that I have a detailed understanding of the state of the art during the relevant period, as well as a sound basis for opining how persons of skill in the art at that time would understand the technical issues in this case.

26. Additional details about my employment history, fields of expertise, and publications are included in my curriculum vitae (attached as Appendix A).

III. MATERIALS CONSIDERED

27. My analysis in this Declaration is based on my knowledge and experience. Based on my above-described qualifications in Section §II, the Patent Trial and Appeal Board should consider me to be an expert in the field. Also, based on my experiences, I understand and know of the capabilities of persons of ordinary skill in this field.

28. As part of my independent analysis for this Declaration, I have considered the following: the ’300 patent (EX1001) and its prosecution history (EX1002); the background knowledge/technologies that were commonly known to persons of ordinary skill; my own knowledge and experience gained from my work in the field; my experience in teaching and advising others in this field; and my experience working with others involved in this field. In addition, I have analyzed the following publications and materials:

- EX1004 U.S. 2016/0273196 to Funk (“Funk”)
- EX1005 U.S. 11,111,464 to Lewis (“Lewis”)
- EX1006 U.S. 10,662,614 to Eckrote (“Eckrote”)
- EX1007 U.S. 2006/0070746 to Lumpkins (“Lumpkins”)
- EX1008 U.S. 4,185,539 to Stratienko (“Stratienko”)
- EX1009 U.S. 5,169,277 to Orser (“Orser”)
- EX1010 U.S. 8,118,111 to Armas
- EX1011 U.S. 5,413,181 to Keigley
- EX1012 U.S. 2008/0116403 to Shelbourn
- EX1013 U.S. 2021/0355647 to Stocks
- EX1014 U.S. 2016/0053459 to Webb
- EX1015 U.S. 6,079,938 to Anderson
- EX1016 C.B. Tatum et al., *Partially Automated Grading: Construction Process Innovation*, Journal of Construction Engineering and Management, Vol. 114, No. 1, March 1988

- EX1017 U.S. 8,068,962 to Colvard
- EX1018 U.S. 9,200,900 to Fessler
- EX1019 U.S. 9,988,787 to Wang
- EX1020 Introduction to Hydraulics, HWH Online Technical School, revision date April 22, 2016
- EX1021 Bobcat® S510 Compact Loaders Specifications Sheet, © 2012 B 4474340-EN (12-12)
- EX1022 Case Construction, Skid Steer Loaders Catalog, AP4102CCGB, 08/15
- EX1023 U.S. 3,233,447 to Horrell
- EX1024 U.S. 3,707,984 to Bantz
- EX1025 U.S. 5,921,165 to Takahashi
- EX1026 U.S. 4,090,396 to O'Brien
- EX1027 U.S. 9,611,870 to Jeon
- EX1028 *Public Health Statement: Hydraulic Fluid*, Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, September 1997
- EX1029 U.S. 2017/0226717 to Cherney
- EX1030 U.S. 2017/0138489 to Winkler
- EX1031 U.S. 6,470,912 to Haynes
- EX1032 U.S. 2012/0059554 to Omelchenko
- EX1033 Bobcat Press Release, *New Bobcat Heavy-Duty Grader Attachments Increase Versatility with Labor-Saving Features*, July 24, 2009 (retrieved from https://news.thomasnet.com/fullstory/grader-attachments-have-blades-that-move-6-different-ways-563417)

- EX1034 Backlash v. Lost Motion, DesignNews, August 4, 2002, www.designnews.com/industry/backlash-vs-lost-motion
- EX1035 U.S. 10,322,725 to Cunningham
- EX1036 Fan et al., *Reliability Analysis and Failure Prediction of Construction Equipment with Time Series Models*, Journal of Advanced Management Science, vol. 3, No. 3, Sept. 2015
- EX1037 U.S. 10,776,880 to Dalal
- EX1038 *The Dangers of Hydraulic Leaks*, Mac Hydraulics, January 16, 2017, retrieved from https://mac-hyd.com/2017/01/16/dangers-hydraulic-leaks/
- EX1039 *Two Simple Solutions to Prevent Hydraulic Cylinder Drift*, Aggressive Hydraulics, dated August 27, 2015, retrieved from https://www.aggressivehydraulics.com/two-simple-solutions-to-prevent-hydraulic-cylinder-drift/
- EX1040 U.S. 7,970,519 to Green
- EX1041 Richard & Vivalda, *Mathematical Analysis of Stability and Drift Behavior of Hydraulic Cylinders Driven by a Servovalve*, Transactions of the ASME, vol. 124, March 2002, pp. 206-213
- EX1042 Level Best Precision Grading Brochure, ATI Corporation, © 2018

29. Note that my citations to non-patent literature throughout this Declaration reference the absolute page number added to the exhibit (as opposed to the original pagination of the document). For patent literature, I've used the column/line numbers or paragraph numbers. Note also that, unless I've indicated

otherwise, all emphasis (bold/italics/underline) in any quoted text are ones I have added.

30. Although I cite and quote to selected portions of various references in this Declaration, the reader should understand that these citations are representative examples. A POSITA would have viewed each reference in its entirety and in combination with other references. Accordingly, I intend the references identified in this Declaration to be viewed as incorporated in their entireties.

IV. SUMMARY OF CONCLUSIONS

31. This Declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- **Ground 1A:** Claims 1-4 are obvious in view of Funk and Lewis. *See Infra*, §VIII.
- **Ground 1B:** Claims 1-4 are obvious in view of Funk, Lewis, and Stratienko. *See Infra*, §IX.
- **Ground 1C:** Claims 2 and 4 are obvious in view of Funk, Lewis, and Orser. *See Infra*, §X.
- **Ground 1D:** Claims 2 and 4 are obvious in view of Funk, Lewis, Stratienko, and Orser. *See Infra*, §XI.
- **Ground 2A:** Claims 1-4 are obvious over Eckrote and Lumpkins. *See Infra*, §XII.

- **Ground 2B:** Claims 1-4 are obvious over Eckrote, Lumpkins, and Stratienko. *See Infra*, §XIII.
- **Ground 2C:** Claims 2 and 4 are obvious over Eckrote, Lumpkins, and Orser. *See Infra*, §XIV.
- **Ground 2D:** Claims 2 and 4 are obvious over Eckrote, Lumpkins, Stratienko, and Orser. *See Infra*, §XV.

V. LEGAL PRINCIPLES

32. In forming my analysis and conclusions expressed in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Person of Ordinary Skill in the Art

33. I understand that the factors considered in determining the ordinary level of skill in a field of art include: the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art regarding solutions to such problems; and the sophistication of the technology at the time of the alleged invention's effective filing date. I understand that a person of ordinary skill in the art ("POSITA") is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above and knowledge of all relevant prior art references, including the references I cite in my analysis below.

B. Obviousness

34. I have been informed that a patent claim is invalid as "obvious" in light of one or more prior art references if it would have been obvious to a POSITA at the time of the alleged invention's effective filing date, taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long-felt but unresolved need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) "copying" of the claimed invention by others.

35. I have been informed that the '300 patent was filed on August 4, 2018 with no claim to a priority right regarding any earlier-filed patent applications. Accordingly, for purposes of my obviousness analysis, I have applied a date of August 4, 2018 as the date of the alleged invention's effective filing date ("Critical Date"), although in many cases the same analysis would hold true even if the Critical Date were earlier or later.

36. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify or supplement the single prior art

reference, or to combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference(s) themselves, the knowledge or "common sense" of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

37. I understand that an obviousness determination also requires that a POSITA would have had a reasonable expectation of success. This concept has been explained to me as relating to the relative likelihood or predictability—from the perspective of a POSITA—of successfully supplementing and/or modifying the prior art in a manner that would meet the claimed limitations of the patent being challenged (here the '300 patent). I understand that the expectation of success need only be "reasonable" and, thus, does not require the absolute certainty gleaned from physically creating the proposed prior art modification.

C. Claim Interpretation

38. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted

according to their "ordinary and customary meaning." In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to a person of ordinary skill in the art at the Critical Date. I also understand that the structure of the claims, the specification and file history may be used to better construe a claim. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term.

39. I have been informed by counsel for Petitioner that the parties may propose explicit constructions for certain claim terms in the '300 patent in the co-pending litigation. I am not involved in the co-pending litigation and do not have direct knowledge of the events in that proceeding.

VI. PERSON OF ORDINARY SKILL IN THE ART

A. A POSITA's Ordinary Level of Skill

40. Based on my knowledge and experience in the field and my review of the '300 patent and its file history, I believe that a POSITA would have included (1) a bachelor's degree in mechanical engineering or a closely-related field, and (2) at least two years of professional experience working with hydraulic systems and/or earthmoving equipment and vehicles. Additional years of experience could substitute for an advanced-level degree (and vice versa). For example, a person

with multiple years of experience working with hydraulic systems might be a POSITA despite not having formal education, because significant experience can substitute for education.

41. The POSITA described above would be capable of performing various design tasks related to hydraulically-controlled work equipment and would understand the basic mechanical and fluid features related to the operation of a hydraulically-controlled dozer blade. The POSITA would also have at least a basic knowledge of how hydraulic control operates in the context of work equipment, including a basic understanding of concepts related to fluid mechanics, solid mechanics, and materials science as they relate to hydraulically-controlled work equipment. From their education and/or experience, a POSITA would also have a basic understanding of closed loop control as it relates to the movement and control of work implements, such as grading blades, and, generally, the function of closed loop control to achieve grading blade position with respect to the skid loader and the surface being graded.

42. Accordingly, my analysis and conclusions expressed in this Declaration are based on the perspective of a POSITA having this level of knowledge and skill. My education, technical expertise and personal knowledge discussed in Section §II shows that I meet the qualifications of a POSITA.

B. A POSITA's Background Knowledge

1. Background of the Technology

43. As I will explain in more detail below in Section §VI, the '300 patent's inventor claims to have invented "stabiliz[ing] the dozer blade attachment assembly by limiting the main arm…movement," a well-known and rudimentary idea that the inventor employed because parallel technological advances by others eliminated the need to avoid tilting the dozer blade. EX1001, 1:43-2:3 (explaining how "the advent of higher resolutions with the wide area augmentation system global positioning system (WAAS-GPS)" obviated blade-mounted laser masts). But the inventor was mistaken. This technology was not new or inventive by the 2018 Critical Date of the '300 patent, and the '300 patent's inventor came to this common-sense conclusion too late. As I will explain below, the idea of supporting a skid-steer main arm[1] on a stop while inhibiting its movement to enhance stability was well known before the '300 patent, as shown by prior art references like Eckrote and Lewis.

44. I have cited numerous patent documents and other non-patent literature throughout this declaration that support my understanding, each of them preceding the '300 patent. A POSITA would have known of these references and

[1] Note that the terms "main arm(s)" and "lift arm(s)" are used interchangeably throughout this declaration to refer to the movable arm assembly of a skid-steer or other machine.

considered them representative examples regarding the state of the art. Accordingly, my obviousness analysis below in Sections §§VIII-XV is informed by these references, as well as my personal knowledge and experience.

2. Automatic Grade Control Techniques

45. Grading is a process of achieving a desired level, sloped, or contoured land surface using machines with a cutting blade to move and shape materials on the ground (e.g., earth materials like dirt, soil, mineral, rocks, etc.). EX1016, 1, 3-4. Grading includes changing the contour of the land, which can include leveling the land and additionally can include the creation of slopes. The goal of grading is to create land that is suitable for a given purpose—e.g., shaping fill, building structures, roads, or other portions of site development or to prepare land for agricultural endeavors. *Id.*, 1.

46. String line systems were one of the earliest grading techniques used. A string would be drawn and supported by grading stakes across a piece of land. EX1017, 4:59-5:4. Workers would use the string lines as visual guides to control the height and angle of the equipment blades. EX1016, 3-4. Equipment operators or ground crew would manually adjust the blade position to match the string line. *Id.*

47. Laser level systems introduced more precision and efficiency compared to string lines. EX1016, 5, 9. Their popularity grew in the 1980s. *Id.*,

9. A laser transmitter mounted on a tripod would emit a rotating laser beam to establish a consistent reference plane. EX1018, 1:25-32; EX1016, 5. A laser receiver mounted on the grading equipment (often coupled by a mast) would detect the laser beam and provide real-time feedback to the control system regarding the position of the grading implement (blade) relative to the laser beam. EX1016, 5. The control system would then adjust the blade height automatically or visually indicate to the operator which way the blade should be moved. EX1016, 6.

48. Global Positioning System (GPS) technology has more recently emerged as an alternative grading reference tool for directing blade position. EX1019, 2:18-49. GPS technology allows for real-time adjustments to the blade's position, ensuring that grading is done according to the exact specifications of the project plan. *Id.*, 3:24-52. This technology also allows for comparison between the cutting tool and the vehicle orientation to enable more accurate grading. *Id.*, 4:50-58.

49. Automatic grade control systems[2] were well known—and commercially available—by the Critical Date. For example, Bobcat featured a laser-control system for grading as early as 2009. EX1033, 1. By 2006, "[a] number of systems [had] been developed in which the position of the earthmoving

[2] I sometimes refer to automatic grade control systems as "AGC systems" or "AGCS" herein for brevity.

apparatus is determined with a laser, GPS or optically referenced positioning system." EX1040, 1:18-23.

50. Although the '300 patent discusses laser grading systems (*see* EX1001, 1:43-54) and GPS-augmented laser grading systems (*see id.*, 1:55-63), the claims of the '300 patent do not recite any details of such a system. Instead, as discussed below, independent claim 1 requires "[a] method for controlling a dozer blade controlled by an automatic grade control system" and "operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface." No particular type of automatic grade control system is required by the claim.

3. Hydraulic Equipment Control

51. Hydraulic systems are integral to modern construction equipment due to their ability to provide high power in a compact, efficient, and easily controllable manner. These systems use fluid pressure to transmit power, offering precise control over a variety of functions in machines such as skid-steer vehicles.

52. Hydraulic systems transmit power through the flow of a pressurized fluid, e.g., hydraulic oil. EX1020, 14. Hydraulics are not only used for enabling lifting and movement but can also provide precise control of motion and force, which is crucial for tasks requiring accuracy, repeatability, and efficiency. *Id.*, 1.

53. Hydraulic systems share common components such as pumps, valves, actuators (e.g., cylinders, motors), reservoirs, and hydraulic fluid. *Id.*, 14.

- Pump: Converts mechanical energy into hydraulic energy, creating fluid flow. *Id.*, 7, 14.
- Valves: Controls the direction, pressure, and flow of the hydraulic fluid. *Id.*, 14.
- Cylinders: Actuators that convert hydraulic energy into linear mechanical motion. *Id.*, 7, 14.
- Motors: Actuators that convert hydraulic energy into rotational motion. *Id.*, 12, 14.
- Reservoir: Stores hydraulic fluid and helps dissipate heat. *Id.*

54. Example uses of hydraulics in skid-steer vehicles include control and use of the lift arms, attachment control, and machine control.

55. Lift Arms: Hydraulic cylinders control the lift arms, allowing the skid-steer to raise and lower attachments like buckets, blades, or forks. Operators can precisely control the height and angle, essential for loading and unloading materials. EX1021, 2.

56. Attachment Control: Skid-steers use hydraulics to operate various attachments, such as augers, trenchers, and hydraulic hammers. Quick-attach

systems enable the operator to switch between attachments without leaving the cab of the machine. *Id.*

57. Steering and Drive: Many skid-steers use a hydrostatic drive system, where hydraulic motors power the wheels. This allows for smooth and precise control of speed and direction, essential for maneuvering in tight spaces. *Id.*

58. Hydraulics are controlled by an operator or through autonomous or semi-autonomous control mechanisms.

59. Joystick Controls: Modern skid-steers are often equipped with joystick controls that use electronic sensors to operate hydraulic valves, offering intuitive and responsive handling. EX1022, 7.

60. Foot Pedals: Some functions, like auxiliary hydraulic outputs for attachments, may be controlled via foot pedals, allowing operators to use both hands for steering and primary functions. EX1021, 2.

61. Automatic Systems: Advanced skid-steers might include automated control systems that adjust hydraulic pressure and flow based on real-time feedback, enhancing efficiency. *Id.*

62. Hydraulics in construction equipment like skid-steers provide the versatility and power needed to perform a wide range of tasks, from earthmoving to material handling, with precision and reliability. EX1022, 13.

4. Hydraulic Equipment Leakage

63. Hydraulic system leakage is a critical concern that affects the performance and reliability of hydraulic machinery. EX1023, 1:69-71; *see also generally* EX1041. Leakage can occur internally within components or externally from the system, each presenting distinct challenges. A brief technical overview of hydraulic leakage follows:

a. Internal Leakage

64. Internal leakage occurs within and between hydraulic components such as pumps, valves, motors, and cylinders. *See* EX1024, 1:7-13; EX1025, 1:23-35. Internal leakage is often caused by wear and tear, poor clearances, or seal failures. EX1026, 1:14-22; EX1025, 1:23-35. Internal leakage often results in a loss of efficiency as the hydraulic fluid bypasses the designed flow path, reducing system performance, causing unexpected movement, or causing the system to fail entirely. EX1026, 1:52-59; EX1027, 1:24-31; EX1024, 1:7-13.

b. External Leakage

65. External leakage results in fluid that escapes from the hydraulic system to the external environment. External leakage often occurs at connections, seals, hoses, and fittings. EX1023, 1:46-50, 4:13-19. External leakage can lead to fluid loss and contamination, degrade positional accuracy and repeatability of hydraulic cylinder movements, and introduce environmental hazards. EX1028, 2; EX1038, 2, 5-6.

c. Causes of Leakage

66. Leakage can be caused by a variety of factors and components. For example, leakage is often caused by the failure of failure seals and O-rings, component wear, improper maintenance, high operating pressures, and temperature effects. EX1030, [0045]; EX1031, 1:45-56.

d. Hydraulic Drift

67. Internal hydraulic leakage can cause hydraulic drift. EX1024, 1:7-13; EX1031, 1:17-21. Hydraulic drift is the unintended and gradual movement of hydraulic actuators, such as cylinders, when the system is supposed to be stationary. EX1024, 1:7-13. This phenomenon can occur in various types of hydraulic machinery and is often an indication of internal issues (commonly leakage) within the hydraulic system. EX1031, 1:17-21. As discussed, hydraulic mechanisms wear over time and this wear may, in turn, increase leakage that leads to drift. EX1023, 1:29-34; EX1031, 1:53-60.

68. Hydraulic drift occurs due to various causes including internal leakage from seals, valves or pumps, a loss of pressure to the system or external forces. EX1024, 1:7-13; EX1039, 1. Hydraulic drift can have various implications on the system and operator. First, in some situations unintended movement of hydraulic equipment can pose significant safety risks to operators and bystanders. For example, in lifting applications, drift of the lift arms can cause the load to shift or

fall unexpectedly. Second, drift can cause inaccuracies in positioning that lead to operational inefficiency. These inaccuracies can affect the precision of tasks such as material handling, machining, or construction and can result in reduced productivity and the need for frequent manual adjustments. *See* EX1028, 1-2. Third, continuous drift may lead to increased component wear. Continuous drift and the associated corrective actions can accelerate wear on hydraulic components, requiring more frequent maintenance and contributing to shorter equipment lifespan. Finally, hydraulic system leakage can additionally lead to environmental impacts (spilling hydraulic fluid onto the ground or water sources), increased operating costs (costs of replacing fluid and seals, and other repair costs), and safety risks (hydraulic fluid is often flammable and can pose a fire risk if leaks occur near ignition sources, and hydraulic fluid leaks can result in slippery surfaces which can be hazardous for nearby operators and personnel). *See* EX1038, 4-6.

69. By understanding and addressing the technical aspects of hydraulic leakage, operators and maintenance personnel can improve the reliability, efficiency, and safety of hydraulic systems in construction equipment.

e. Lost Motion

70. The term "lost motion" describes the condition where an input to a mechanism yields no corresponding displacement at the output due to tolerances, elasticity, or slack in the system. EX1034, 3; EX1035, 4:17-27. Lost motion

affects the precision and repeatability of motion systems, especially at changes in direction. EX1034, 3; EX1035, 4:17-27. Clearance between components such as pinned joints or any loose-fitting components can cause lost motion. EX1035, 4:17-27. Lost motion arises because the input to the mechanism first has to 'take up the slack' before the output mechanism begins to react. EX1034, 3. This phenomenon occurs in the pin joints used in skid-steer loader lifting mechanisms.

5. Job Site Considerations

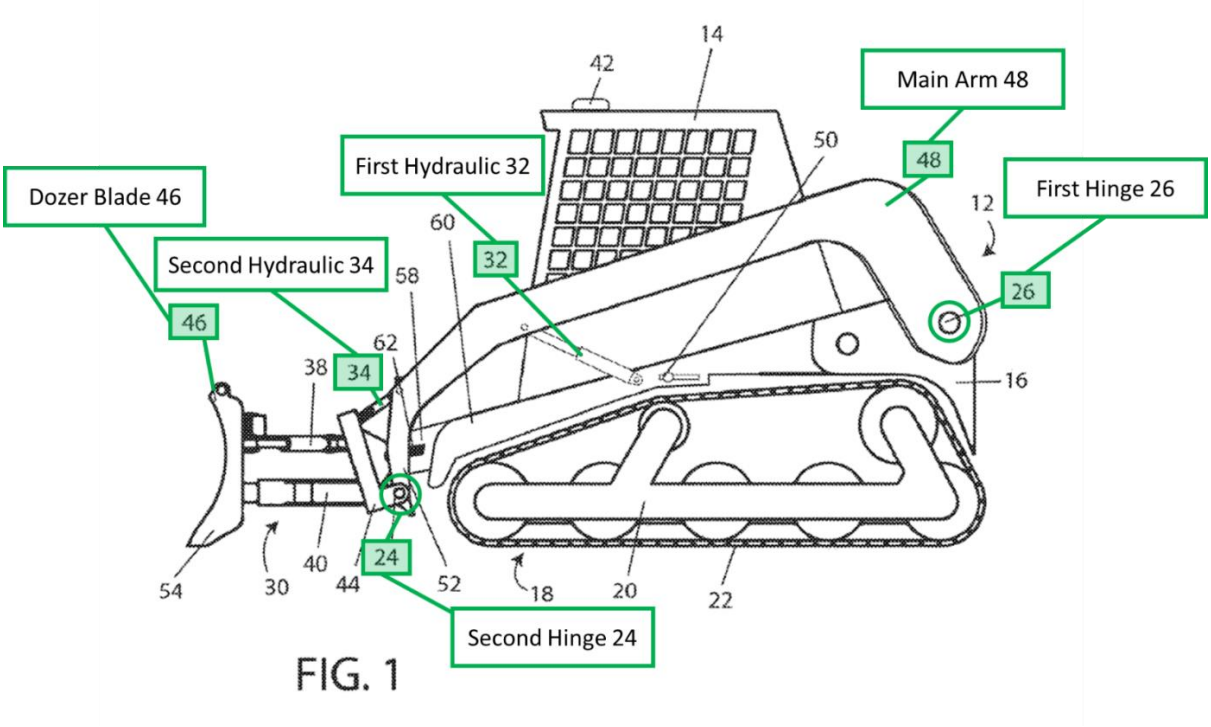
71. Cost is an important concern in this context, as construction contractors typically bid for projects. EX1016, 10. Effective cost management strategies are essential to maximize resource utilization and minimize waste. These strategies include minimizing downtime from equipment repair, which can lead to costly delays beyond just the cost to repair the equipment. EX1036, 1. This is especially true in remote locations. EX1019, 2:60-67. Redundancy of equipment is a strategic approach to prevent downtime, but it typically comes with a higher upfront cost for keeping critical spare equipment operational and onsite. EX1036, 3.

72. Worker time efficiency is crucial in maintaining project timelines and productivity, as this has knock-on effects which can impact scheduling and equipment availability. EX1016, 3-4, 9. Likewise, worker safety is generally an important consideration. EX1037, 1:15-29.

VII. THE '300 PATENT

A. Description of the '300 Patent (EX1001)

73. The '300 patent is about "skid steer vehicles used to grade earth using a dozer blade…[and] automatic grade control equipment." EX1001, Abstract. The '300 patent's Figure 1 (annotated below) illustrates an exemplary skid-steer featuring a main arm 48 supporting a dozer blade attachment 46. *Id.*, 4:39-48, 5:4-22. This exemplary skid-steer includes a first hydraulic 32 that tilts the main arm 48 about a first hinge 26 and a second hydraulic 34 that tilts the dozer blade 46 about a second hinge 24. *Id.*, 4:39-48, 5:67-6:54, 7:1-25. The height of the bottom of the dozer blade 46 relative to the ground "controls the depth of the cut" during grading, and the blade height is "manipulated by [an] automatic grading computer" selectively actuating the second hydraulic 34. *Id.*, 6:17-36, 8:21-26. As the second hydraulic 34 tilts the blade 46, the main arm 48 is immobilized, resting against a stop in a lowered position. *Id.*, 5:23-45, 8:4-20, 8:26-39.



EX1001, Fig. 1 (annotated)

74. The ’300 patent concedes that using skid-steers with dozer blades for earth grading was known. EX1001, 1:14-28 (“Several designs for improvement to earth moving equipment have been designed in the past...[however t]he Armas prior art maintains the full movement of the main arm of the vehicle to raise and lower the attachment assembly including the dozer blade”); *see also id.*, 3:33-39 (“Skid steer vehicles are commonly commercially available…”). The ’300 patent further concedes that automatic grading systems were known and used to control such skid-steers—and, as I explain below, points to other patents by the inventor that disclose just this. *Id.*, 1:18-45, 3:44-45 (“Grade control systems, such as laser automation, are commonly commercially available”). As I explained above, laser

automation systems used a laser positioned at a fixed location at the worksite and a receiver coupled to the dozer blade by a mast. *Supra* §VI.B.2. The '300 patent describes that "[w]ith the prior art laser control systems the dozer blade supported the laser control receiver mast… so that the system could use the top of the mast as a datum for referencing the height of the bottom of the dozer blade the[sic] defined the grade being made as the dozer moved over the earth defining the new grade." EX1001, 3:61-66.

75. Indeed, the inventor of the '300 patent disclosed these concepts of skid-steer dozer blades for grading and with an automatic grade control system in a commonly-owned prior patent—U.S. 8,118,111. *Id.*, *see also* EX1010. For example, the abstract of the 8,118,111 patent states: "The present device is generally a stabilizer bracket for small to mid-sized skid steer vehicles used to grade earth using a dozer blade in conjunction with remote grade control equipment (such as laser automation or other automated leveling system)." EX1010, Abstract. As I have stated, the '300 patent's only distinction from this admitted prior art is "stabiliz[ing] the dozer blade attachment assembly by limiting the main arm … movement," a rudimentary idea derived from the fact that parallel technological advances made by others, including advances in grade control systems, had eliminated the need to avoid tilting the dozer blade. EX1001, 1:43-2:3 (explaining how "the advent of higher resolutions with the wide area

augmentation system global positioning system (WAAS-GPS)" obviated blade-mounted laser masts). As I will describe below, by the time of the '300 patent, Eckrote and Lewis had already disclosed the idea of supporting a skid-steer main arm on a stop while inhibiting its movement to enhance stability.

VIII. GROUND 1A—OBVIOUSNESS OVER FUNK AND LEWIS

A. Funk (EX1004)

76. Funk describes a skid-steer vehicle featuring an "automatic leveling control system for a machine having a work attachment adapted for leveling as the machine is propelled about a worksite." EX1004, Abstract. For example, Funk discloses "[a] controller [that] is configured for generating a control signal…to adjust at least one of a height of the lift arms and the tilt angle of the work attachment mounting structure such that a grading edge of the work attachment is maintained at elevation as the machine is propelled about the worksite." *Id.*, [0013].

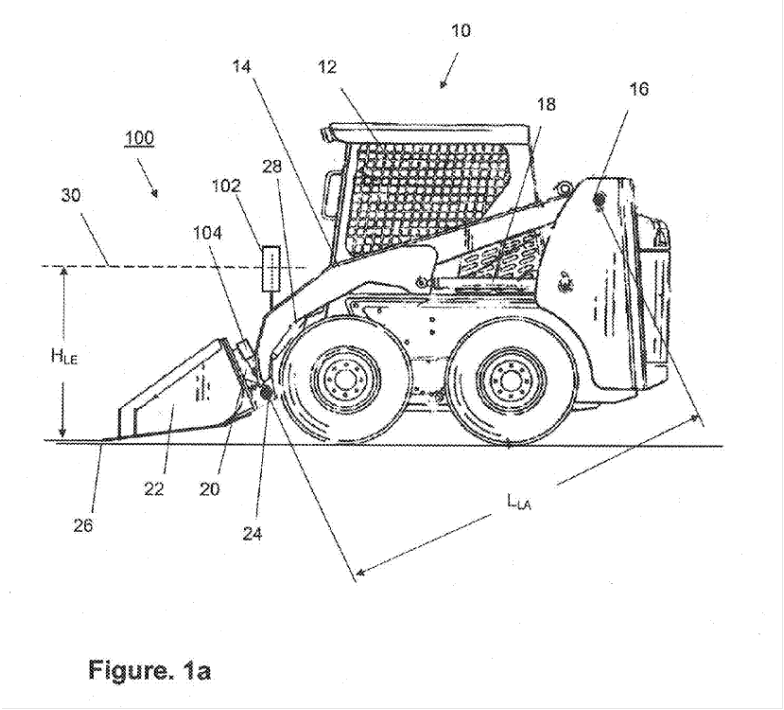


Figure. 1a

EX1004, Fig. 1A

B. Lewis (EX1005)

77. Like Funk, Lewis is about a control system for a skid-steer vehicle. Lewis recognizes that "[b]locking upward movement of the arm beyond [a set] intermediate position may enable the maximum horizontal load rating of the arm/arm assembly." EX1005, 4:34-36. "In certain embodiments, the intermediate position of the arm may correspond to the lowered position of the arm," such that "the arm may contact the chassis of the work vehicle or a stop coupled to the chassis of the work vehicle." *Id.*, 6:54-61. For example, "[i]n certain embodiments disclosed herein, while a restricted-height implement, such as a dozer blade, is coupled to the arm, upward movement of the arm beyond the intermediate position is blocked, thereby enabling the maximum horizontal load

rating of the arm/arm assembly to be increased while the restricted-height implement is coupled to the arm." *Id.*, 4:54-60.

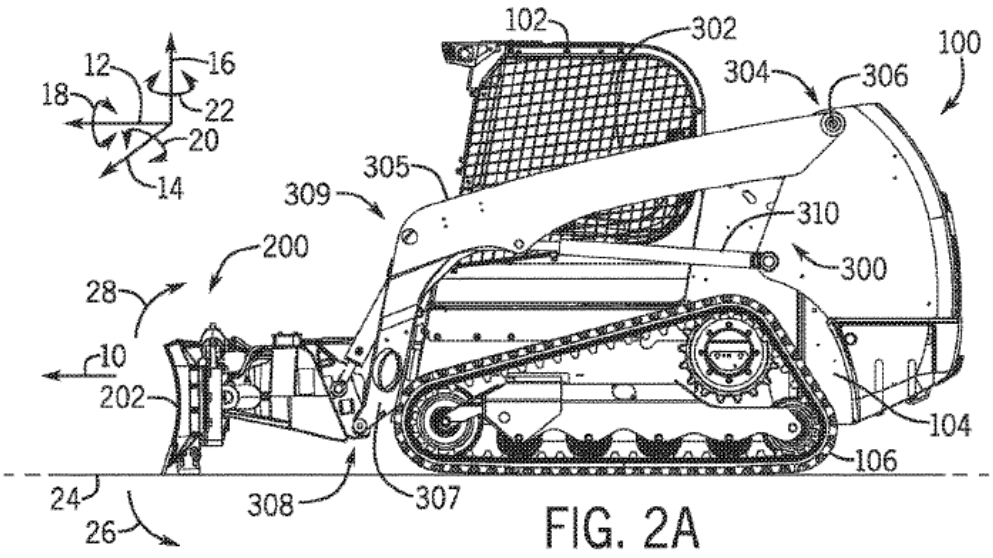


FIG. 2A

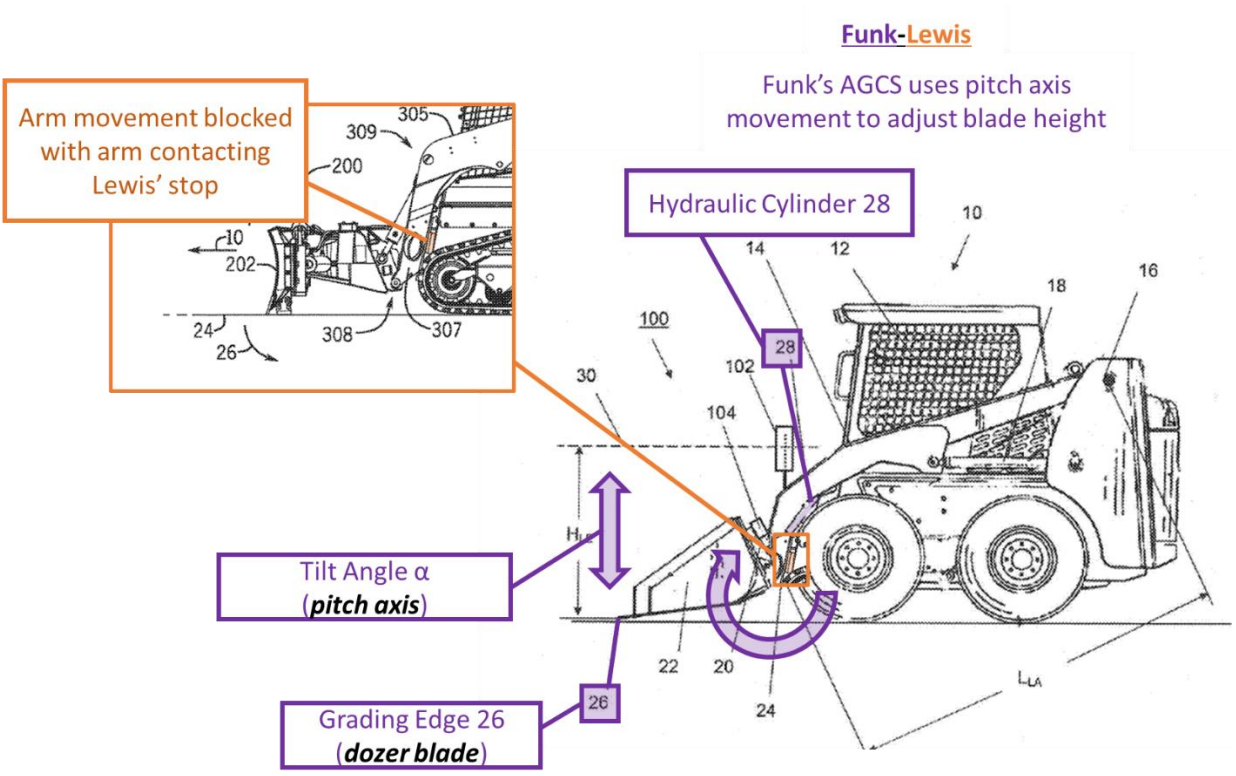
EX1005, Fig. 2A.

C. The Funk-Lewis Combination

78. The Funk-Lewis combination represents the predictable result of applying Lewis's supplemental teachings about blocking upward movement of the skid-steer's main arm in the context of Funk's teachings about skid-steer vehicles with an automatic grade control system for adjusting the height and tilt angle of a mounting structure to maintain the work attachment at a particular elevation. From a POSITA's perspective in 2018, integrating the supplemental teachings of Lewis with Funk's skid-steer automatic grade control system would have involved nothing more than applying known solutions to known problems in the field of hydraulic systems for earthmoving equipment and vehicles to achieve a predictable

outcome—namely, a skid-steer vehicle where the main arm is immobilized and rests on a stop while an automatic grade control system adjusts the height of a dozer blade via movements about a pitch axis. As I explained above, a POSITA would have been familiar with hydraulic systems and integrating an automatic grade control system into a skid steer equipped for earth-moving operations (like Lewis describes) would have been well within the POSITA's skill level.

79. The fundamental aspects of Funk's disclosure would remain intact, bolstered by the well-known and beneficial teachings of Lewis to arrive at the '300 patent's claimed invention. As I explain below, a POSITA would have had many good reasons to combine the teachings of Funk and Lewis. To be clear, the combination of Funk and Lewis discussed below is a combination based on the teachings of Funk and Lewis. I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other.



EX1004, Fig. 1a (annotated) (modified to include EX1005, Fig. 2a, inset)

1. Reasons to Combine

80. A POSITA would have been motivated to pursue the Funk-Lewis combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

a. Known and Predictable Advantages

81. A POSITA would have understood that the integration of Lewis's teaching to block upward movement of the main arm with Funk's skid-steer vehicle would have the predictable advantage of maximizing the horizontal load rating of the arm assembly during grading (just as Lewis teaches). EX1005, 4:34-37 ("Blocking upward movement of the arm beyond the intermediate position may

enable the maximum horizontal load rating of the arm/arm assembly to be increased while a restricted-height implement is coupled to the arm."), 5:33-35 ("[T]he arm 302 may be configured to support the greatest horizontal load while the arm 302 is in the illustrated lowered position."), 6:61-65 ("As a result of the contact between the arm and the chassis/stop, a portion of the horizontal load applied to the arm by the restricted-height implement may be transferred to the chassis at the point of contact."), 5:59-6:15, 11:5-24. From the POSITA's perspective, maximizing the horizontal load rating would serve to bolster the arm assembly to withstand horizontal forces of a magnitude that would otherwise cause a partial or catastrophic component or system failure during grading.

82. For example, Lewis describes that "the arm/arm assembly may be configured to support varying horizontal loads based on the position of the arm," e.g., supporting a larger horizontal load in the lowered position and a supporting a smaller horizontal load in a raised position. EX1005, 4:42-43. Lewis describes that the maximum horizontal load rating can be set based on the type of implement coupled to the arm to enhance the utility of the work vehicle. *Id.*, 4:34-5:6 In particular, Lewis describes that, "while a restricted-height implement, such as a dozer blade is coupled to the arm," the arm is locked so as to prevent upward movement of the arm beyond a set position, "enabling the maximum horizontal load rating…to be increased." *Id.*, 4:55-59.

83. A POSITA would have understood that earth grading often induces high horizontal loads on the arm assembly from digging into, carrying, and pushing earth materials. These horizontal loads are part of a reaction force exerted by the earth materials on the dozer blade as the vehicle provides a forward tractive force during grading. The resulting horizontal loads from the reaction force are transferred from the blade to other components of the linkage that forms the arm assembly. *See* EX1006, 1:8-31. With this understanding, the POSITA would have been motivated to increase the horizontal load rating of Funk's design by implementing Lewis's teaching to rest the main arm against a chassis stop while preventing movement of the main arm. As the POSITA would have recognized, increasing the horizontal load rating in this way, as taught by Lewis, would [i] reduce the likelihood of damaging Funk's arm assembly; and [ii] allow Funk's skid-steer vehicle to operate safely in environments and conditions that induce higher horizontal reaction forces against the dozer blade. This is because the horizontal load on the blade is transferred to a more stable portion of the machine and is not concentrated at the joints or other vulnerable portions of the arm assembly.

b. Multiple Solutions Previously Disclosed

84. A POSITA would have understood that Funk invites the proposed Funk-Lewis design by explaining that automatic grade control can be achieved

with adjustments to "at least one" of the lift arm height or the blade tilt. EX1004, Abstract, [0013], [0033]. Grading adjusts the level or slope of the ground using a blade coupled to the lift arm. *See Infra* §VI.B.2. Adjusting the height of the arm to which the blade is attached controls how the blade engages the ground. EX1004, Abstract, [0013], [0033]. Similarly, the blade's interaction with the ground can also be controlled by adjusting the tilt of the blade. EX1004, Abstract, [0013], [0033]. Funk's disclosure that adjustments can be made to "at least one" of the arm height or blade tilt would have suggested to a POSITA that while both types of adjustments could be used in a grading control system, no more than one is required. EX1004, Abstract, [0013], [0033]. In this way, Funk encourages the POSITA to seek out and explore the predictable result of integrating the supplemental teachings from references like Lewis that promote immobilizing the main arm, leaving just "one" of Funk's two adjustment mechanisms—blade tilt—available for grade control. A POSITA would have recognized, based on Funk's teaching, that grading may be accomplished through adjustment of blade tilt.

c. Implementations Disclosed to Achieved Shared Goal

85. A POSITA would have appreciated that Lewis's teaching to increase the horizontal load rating by simply preventing movement of the main arm aligns with Funk's desire to provide systems that are easily implemented "as a retro-fit to a pre-existing skid steer unit." EX1004, [0006]. A POSITA would have

understood that increasing the horizontal load rating of existing grading equipment without additional modifications to their structures is a desirable objective for designers of these types of grading machines. A POSITA would have been motivated to increase the horizontal load rating to improve performance—such as by increasing the operating work capacity—of existing vehicles with only a minor modification because the improvement would be easily applied to vehicles in the field. From a POSITA's perspective, it would have been clear that increasing the capacity of the vehicle to do useful work increases the productivity of the machine. To explain further, a vehicle with an increased capacity due to an increased horizontal load rating can exert more force to successfully grade under circumstances that induce high horizontal loads, for example making deep cuts into the ground or pushing a large amount of material.

86. Lewis's idea of immobilizing the main arm in a lowered position against a stop "does not rely upon custom bucket attachments" and instead leverages "the factory produced excavation attachments with the full primary hydraulics" as Funk suggests. EX1004, [0006], [0004] (discussing the deficiencies of "[p]rior art systems [that] are not integrated to the earth moving equipment" and rely on "customized bucket attachments" actuated by low-powered "auxiliary hydraulics"). Rather than promoting customized attachments, Lewis's approach abides Funk's instruction "to provide an automatic leveling control system that

[leverages] customization of the hydraulic response of the grading equipment." EX1004, [0006]; *see also* [0004], [0009], [0019]; EX1005, 4:19-5:6. Increasing the horizontal load rating using a system that can be implemented in existing vehicles to improve performance would have appealed to a POSITA as an efficient solution that does not require overly complicated modifications to machines in the field.

d. Using a Single Variable to Enhance Control

87. A POSITA would have understood that Lewis's teaching to prevent movement of the skid-steer's main arm during use would enhance the efficiency and accuracy of Funk's automatic leveling control system by narrowing the degrees of freedom and reducing the number of distinct movements in the arm assembly. EX1004, Abstract, [0013], [0033]; EX1005, 4:34-5:6, 6:54-7:5.

88. For example, preventing movement of the main arm reduces the number of control variables for regulating blade height and, therefore, reduces system complexity. *See* EX1029, [0005] ("[A]s the freedom of blade movement increases, so too does the complexity[.]"). More complex systems with more degrees of freedom "provide[] greater opportunities for sub-optimal positioning of the blade." *Id.* This principle applies to both manual and automatic grading systems. Just as a human user would tend to be less efficient and more prone to error with more control variables, so too would a computer-controlled system (for

at least the reasons I provide below). Immobilizing the main arm in the Funk-Lewis combination reduces complexity and the likelihood of sub-optimal positioning. By only tilting the dozer blade during grading operations, the blade position can be adjusted more efficiently, reliably, and accurately.

89. By holding the main arm fixed, the dozer blade can be adjusted relative to a fixed position of the main arm, simplifying the controls required for grading. *See* EX1011, 3:27-35 ("As common in conventional skid steers, skid steer 2 can be operated in a float mode, wherein lift cylinders 11 are disabled to allow lift arms 10 to rest in a lowered position under their own weight and supported by chassis 4 [and] only the pivot cylinder 17 is operative, thereby reducing the number of operation controls[.]"); *see also id.*, 4:51-63 (explaining that by operation in "float mode" with cylinders disabled and using pivot control "the operation of the [working implement] and skid steer is simplified").

90. Holding the main arm fixed during grading would have additional benefits such as:

- By using an automatic grade control system with the main arm fixed, only the tilt axis of the blade would need to be moved, which can be accomplished more quickly than adjustments of both the blade tilt and the lift arm height together. With this quicker adjustment, grading can be accomplished with increased speed – even a few seconds per adjustment can

add up over the course of a grading job that takes hours. *See e.g.*, EX1042, 6. When grading can be accomplished in less time, the productivity of the machine (i.e., the amount of work that it can accomplish in a time period) is enhanced. The grading operation may be efficiently completed, saving time and money. In some situations, minimizing the number of factors monitored and observed by the operator during grading would also increase the speed with which grading can be accomplished. *See* §VI.B.4.e.

- By limiting the movement of the heavier main arm and instead adjusting the dozer blade, power usage, and thus fuel consumption, can be reduced. *See e.g.*, EX1012, [0045] (explaining that operation of a skid-steer in "float mode" requires "minimal use of vehicle power" so that "[a]vailable vehicle power and hydraulic pressure are therefore maximized for use in non-lifting operations"). A POSITA would have been motivated to decrease operating costs of these energy-intensive machines that are expensive to operate and maintain, by making modifications that reduce required movements for energy savings.
- Reducing the number of cycles required of the hydraulic system during grading operations extends the service life of the main arm hydraulic components. *See* EX1014, [0003] (explaining that "lift cylinders for raising and lowering the lift arms…may be subject to damage when high impact

loads are exerted on them during use"). By holding the lift arm in a fixed position during grading, the hydraulic controls for moving the arm are used significantly less compared to a system that adjusts both the arm and blade tilt, and the hydraulics that move the lift arm experience significantly less wear during grading as a result. *See* EX1011, 4:62-65 (explaining that in "float mode" with the disabled lift cylinders and arms in a lowered position the work implement is adjusted "solely with pivot cylinder 17 [so that] its operation is less taxing on the skid steer's hydraulic systems, which translates into increased performance and life span of the skid steer 2.").

e. Reasonable Expectation of Success

91. A POSITA would have had a reasonable expectation of success in combining the above-discussed Funk-Lewis elements because each element (e.g., Funk's leveling control system and Lewis's skid-steer arm hydraulically controlled to be supported on a stop) can be combined without interfering with the functionality of the other. For example, the POSITA would have understood that adding Lewis's stop to the skid-steer's body and immobilizing the lift arm on the stop would not cause any negative interference with Funk's automatic control, which is capable of operating using only blade tilt control. Further, the addition of the stop would not unduly impair any functions of Funk's skid-steer such as mobility, movement, or utility. Each element of the skid-steer in combination

merely performs the same function as it does separately—the lift arm is held on the stop and the tilt of the dozer blade is controlled by Funk's system for leveling purposes.

92. It would have been well within the POSITA's level of skill to implement such a combination given the advanced state of the art at the time of the '300 patent in 2018. *See Infra* §§VI.B.1-2 Implementing the combination would have involved a simple adjustment to the hydraulic controls of Funk's lift arm and the addition of a stop to the chassis of the skid-steer. EX1004, [0013], Fig. 1A. Such an attachment (e.g., a stop) would be welded or bolted to the chassis.

93. Indeed, as explained above, Funk describes that "at least one of [the] height of the lift arms and the tilt angle of the work attachment mounting structure" is adjusted by the controller to maintain the height of the grading edge, meaning that height of the lift arms alone or tilt angle of the work attachment mounting structure alone would be sufficient. It would have been well within the POSITA's level of skill to adjust the tilt angle of the work attachment mounting structure and hold the height of the lift arms at a set level. Indeed, choosing to disable lift hydraulics in favor of adjusting a pivot cylinder was well-known by the Critical Date. *See* EX1011, 3:27-35 (explaining that it was "common in conventional skid steers" to "operate[] in a float mode, wherein lift cylinders 11 are disabled to allow lift arms 10 to rest in a lowered position under their own weight and supported by

chassis 4 [such that] only the pivot cylinder 17 is operative" to adjust the work implement), 4:62-65 (explaining that in "float mode" with the disabled lift cylinders and arms in a lowered position the work implement is adjusted "solely with pivot cylinder 17 [so that] its operation is less taxing on the skid steer's hydraulic systems, which translates into increased performance and life span of the skid steer 2."). A POSITA would have appreciated that a "float mode" is less taxing on both the hydraulic system of the skid-steer, and less taxing on the mechanical joints and structure of the lift arms.

94. It would have also been within the POSITA's level of skill to use hydraulic control to immobilize the lift arms on a stop positioned on the chassis of the skid-steer, as Lewis teaches. EX1005, 4:34-5:6, 5:59-6:15, 6:54-7:5, 11:5-24, Fig. 2A; *see also supra* §VI.B.3. Resting the lift arms against the chassis was well-known by the Critical Date when operating skid-steers in "float mode" or when otherwise operating skid-steers for grading. *See* EX1015, 1:32-36 ("In some prior art skid steer loaders, a separate lift arm stop is mounted to each side of the main frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"); *see also* EX1014, [0003] ("some skid steer machines have a separate lift arm stop mounted to each side of the frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"), EX1013, [0004] ("It is common for a blade of a grading

system to sit level with the tracks of a vehicle on a ground surface when the vertically movable arms of the vehicle are moved to a lowermost position against stops."); EX1011, 3:27-35.

95. Additionally, it would have been well within the POSITA's level of skill to control the hydraulic cylinder for raising and lowering the lift arm to immobilize the lift arm against the stops, because the lift arms are conventionally controlled by hydraulics. EX1005, 4:1-3 ("The arm assembly 300 also includes lift cylinders 310 (e.g., lift actuators) coupled to the arm 302 and the chassis 104"), 4:19-20 ("movement of the arm 302 is controlled by an arm control system"), 9:34-54 (explaining how the hydraulic lift cylinders 310 function to move the arm); *see also* EX1011, 2:65-67 ("Chassis 4 supports two pivotal lift booms or arms 10, which are raised and lowered by a pair of hydraulic lift cylinders."), EX1014, [0003] ("A pair of hydraulic lift cylinders may be provided for raising and lowering the lift arms"), EX1015, 1:21-22 ("A pair of hydraulic lift cylinders are utilized for raising and lowering the lift arms."); *supra* §VI.B.3.

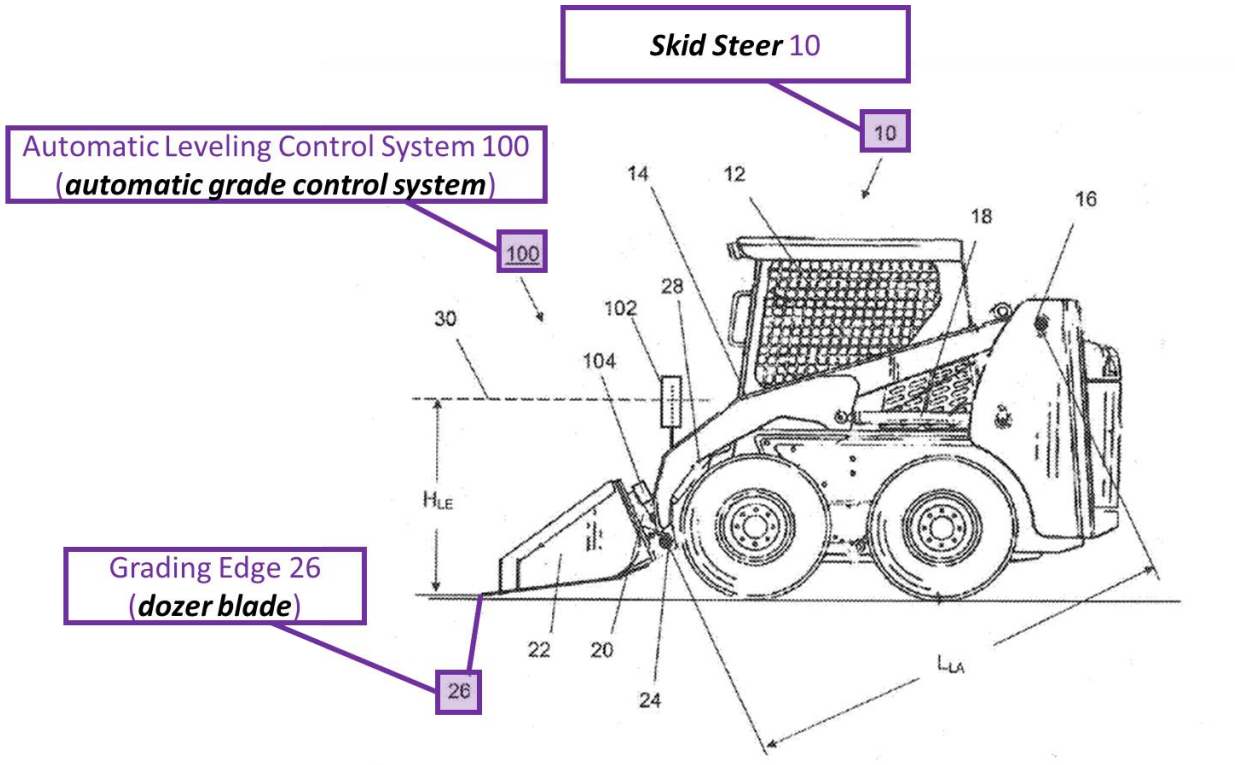
96. Accordingly, it would have been well within the POSITA's level of skill to implement the combination of Funk and Lewis described above.

D. Claim Element Analysis

1. Claim 1

Element [1.pre] A method for controlling a dozer blade controlled by an automatic grade control system on a skid steer vehicle comprising:

97. The Funk-Lewis combination renders obvious Element [1.pre] and Claim 1 as a whole. For example, Funk discloses an "***automatic*** leveling ***control system*** 100 implemented using ***a skid-steer*** 10." EX1004, [0031], [0028] ("automatic leveling control ***method***"); Figures 1a, 5. Specifically, Funk describes utilizing a "***grading*** edge 26 for leveling as the ***skid-steer*** 10 is propelled about a worksite." *Id*., [0031].



EX1004, Fig. 1a (annotated)

98. In Funk's system, "[a] level ***grade*** is achieved by movement of the unit around the work surface [while] maintaining the [grading] edge of the work attachment in a desired plane in relation to a laser plane projected at the worksite." *Id*., [0014]; *see also* [0033]. Thus, a POSITA would have understood and found obvious that Funk's conception of a system that achieves "automatic leveling control" by controlling the position of a "grading edge" provides an ***automatic grade control system***. *See supra* §VI.B.2. Funk's description of controlling the work attachment "such that a grading edge of the work attachment is maintained at elevation as the machine is propelled about the worksite" makes clear that Funk's automatic leveling control system is a system that provides for grading of a worksite – that is leveling or sloping a ground surface. EX1004, Abstract; *see also supra* §VI.B.2. As illustrated in Figures 2 through 4 of Funk, a POSITA would have recognized that Funk's invention includes a controller block diagram (Figure 2), an expected response time of the system (Figure 3) and a controller (Figure 4).

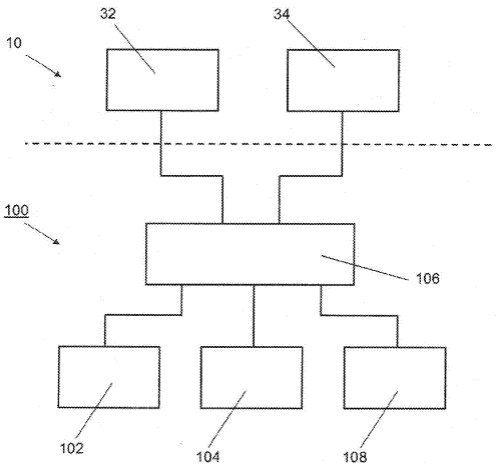


Figure. 2a

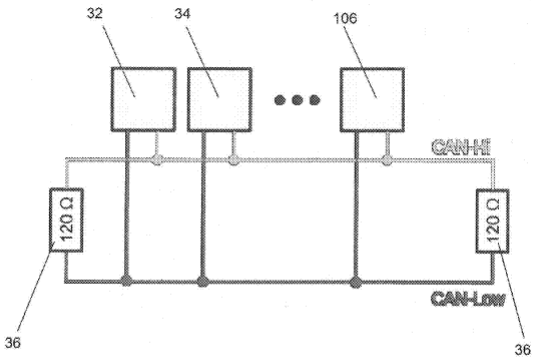


Figure. 2b

EX1004, Figs. 2A-B

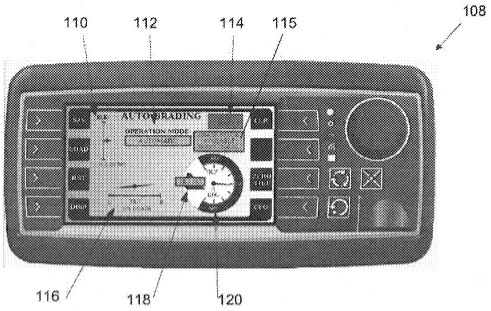


Figure. 4a

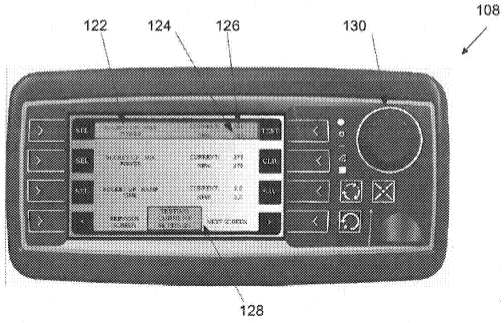


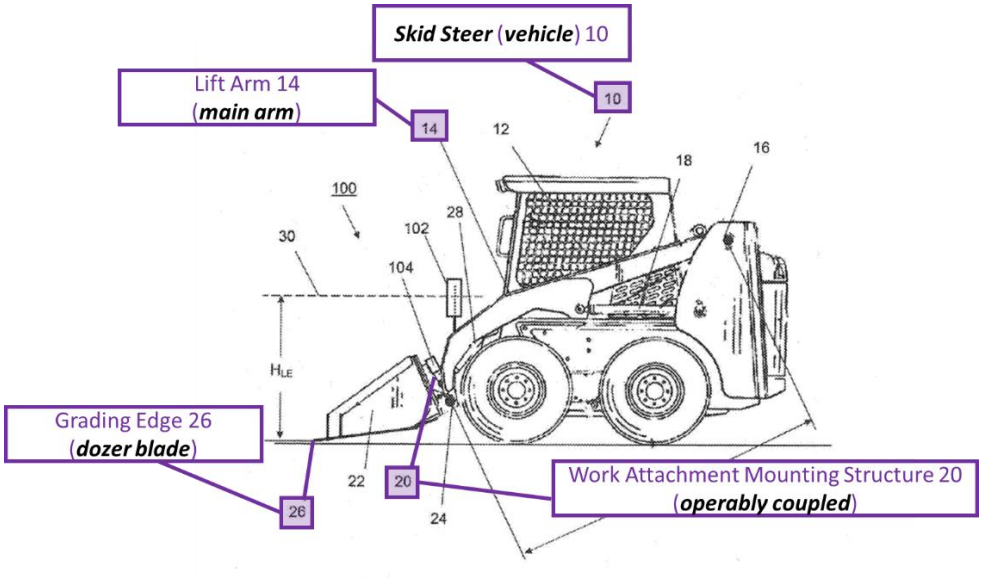
Figure. 4b

EX1004, Figs. 4A-B

99. The automatic grade control system has clear benefits in terms of machine operation, load capacity and service life. *See Infra* § VII.C.1. The POSITA also would have understood and found obvious that Funk's disclosure of a "suitable front edge or working surface such as…[various] types of buckets and ***blades***…for use with other types of machines such as, for example, front loaders and bull***dozers***" implicates ***a dozer blade***. EX1004, [0030].

Element [1.1] providing a skid steer vehicle having a main arm with a front side operably coupled to a dozer blade assembly;

100. The Funk-Lewis combination renders obvious Element [1.1] and Claim 1 as a whole. For example, Funk discloses a "***skid-steer*** automatic laser grading attachment compris[ing] a grading [(***dozer***)] ***blade*** mounted [(***operably coupled***)] to a stabilizing boom [(***main arm***)]." EX1004, [0003]; *see also id*., [0012] (similar).



EX1004, Fig. 1a (annotated)

101. Lewis similarly discloses that "[c]ertain work vehicles (e.g., ***skid steers***) have an ***arm*** movably coupled to the chassis and configured to support an implement (e.g., ***dozer blade***, grapple, etc.)… [f]For example, the arm may support a ***dozer blade*** to facilitate earth-moving operations." EX1005, 1:9-21, 2:39-60, 3:4-38.

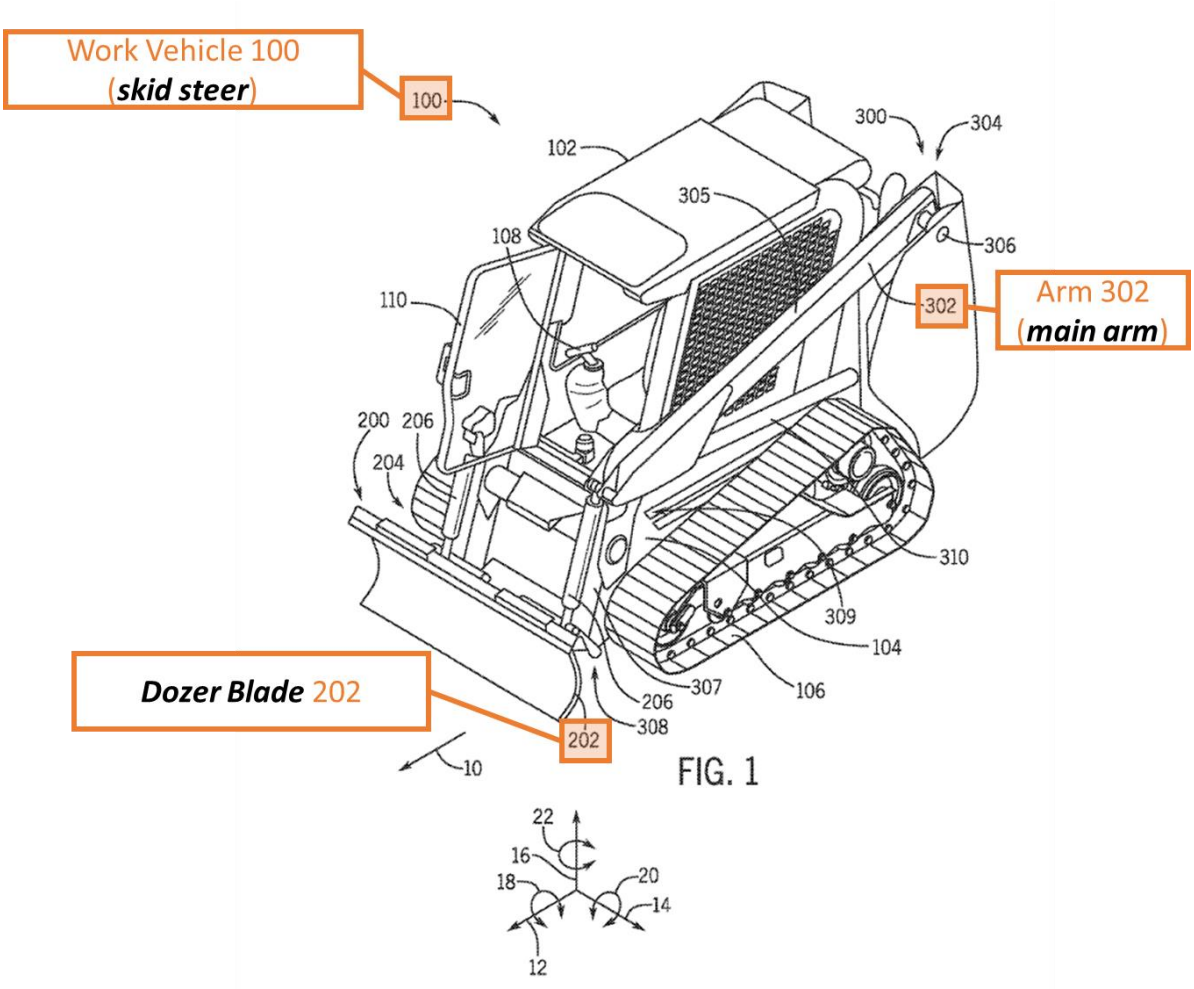
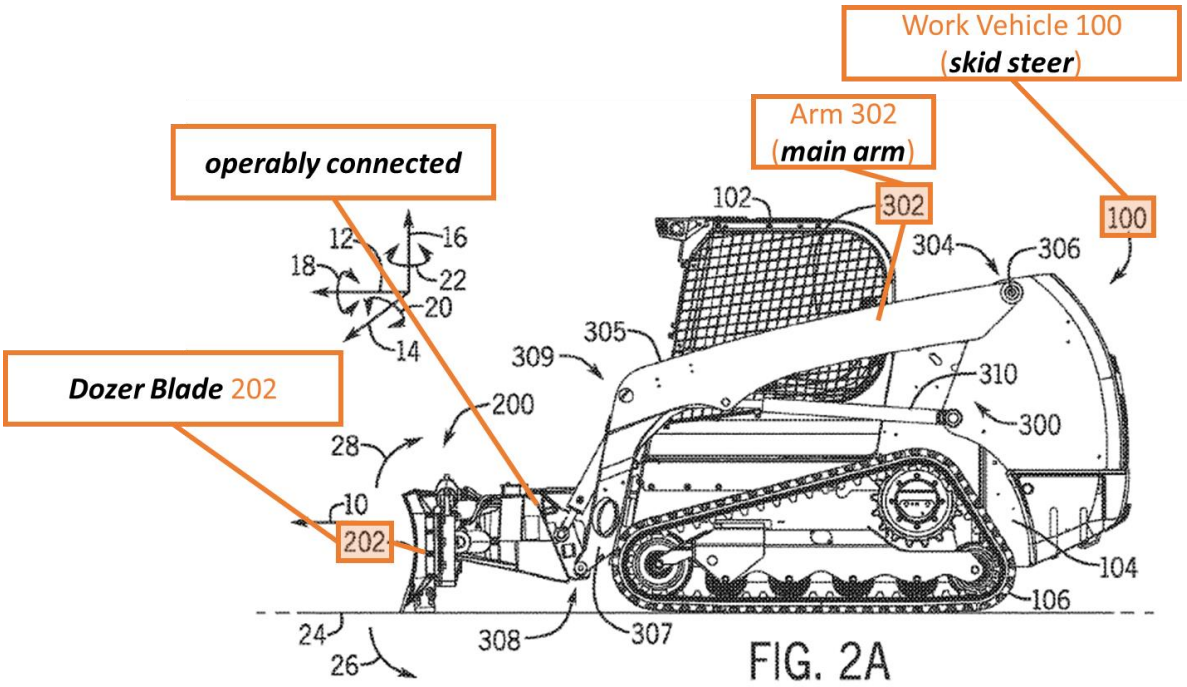


FIG. 1

EX1005, Fig. 1 (annotated)



EX1005, Fig. 2a (annotated)

102. As shown and described in both Funk and Lewis, the ***dozer blade*** is ***operably coupled*** to the ***front*** side of the main arm. EX1004, Fig. 1a; EX1005, 3:4-67, Fig. 2a. Coupling the blade or working implement to the front side of the main arm was a well-known and common configuration for skid-steers by the Critical Date. *See e.g.*, EX1006, Fig. 1A; EX1010, Fig. 1; EX1014, [0013], Fig. 1. It was (and is) typical to mount a working blade to the front side of the machine-because this is where the operator has a clear view of the blade. Mounting the working blade elsewhere on the skid-steer, such as on the side or back of the vehicle, would make it difficult for the operator to observe the blade. The blade is conventionally coupled to the front side of the main arms (and was conventionally

at the Critical Date) so that the operator can observe the blade as it is used and moved.

Element [1.2] providing a stop connected to the skid steer vehicle upon which a point of the main arm rests thereby defining a lower limit of movement of the main arm;

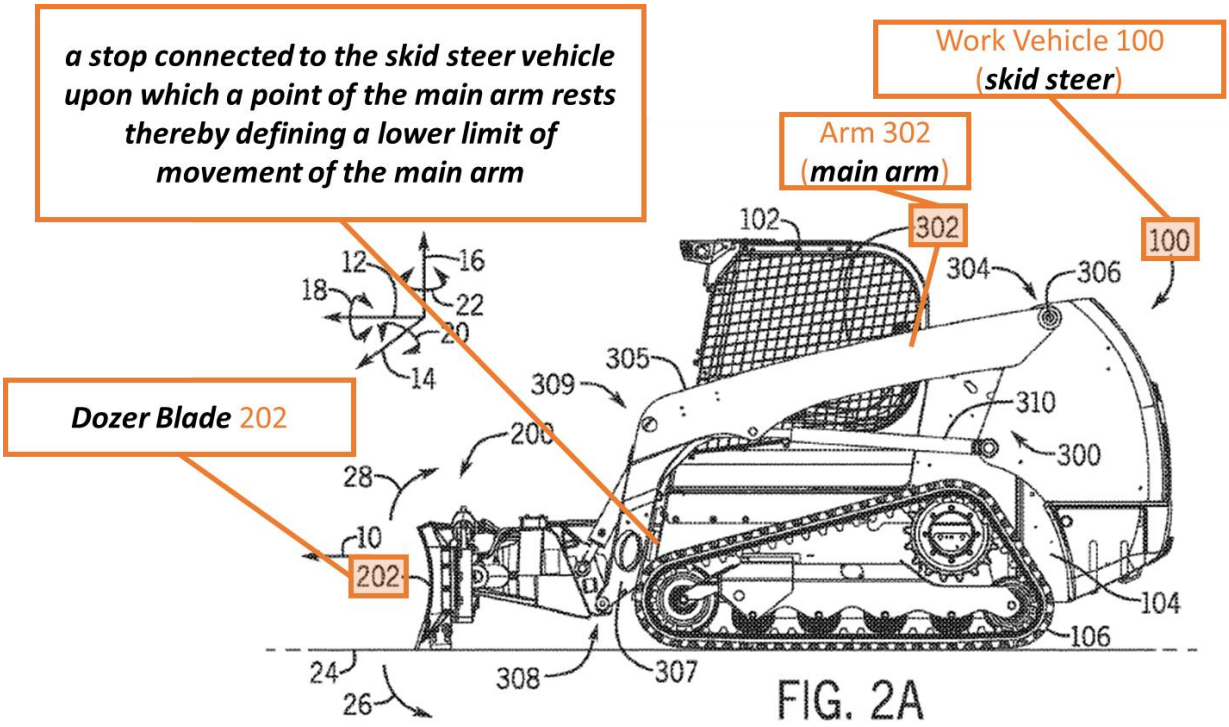
Element [1.3] positioning the point of the main arm against the stop;

103. The Funk-Lewis combination renders obvious Elements [1.2] and [1.3] and Claim 1 as a whole. As discussed at §VIII.C, this combination incorporates Lewis's teaching of immobilizing the ***main arm*** in a ***lowered*** position.

104. For example, Lewis illustrates in Fig. 2A (below) that "***the arm*** 302 of the arm assembly 300 is in a ***lowered*** position" in which "the lowered position of the arm 302 corresponds to the minimum height of the dozer blade 202 relative to the ground 24 along the vertical axis 16." EX1005, 5:20-27. Lewis additionally describes that the "intermediate position of the arm"—the position beyond which "upward movement" is "block[ed]"—"***may correspond to the lowered position,***" where the arm is "configured to support the greatest horizontal load." *Id*., 6:54-55, 4:19-5:6, 5:20-39.

105. When a skid-steer is operated for grading a surface, the blade is pushed against any dirt or ground covering that is above a set height of the blade to smooth or level the surface to the set height. By pushing the blade in a forward direction against the dirt or ground covering, the blade experiences a horizontal

force opposite the direction of motion. This horizontal load on the blade is transferred to the arm to which the blade is coupled. Lewis's directive that when the arm is in the lowered position it can support the greatest horizontal load is a common-sense approach. In this position, the majority of the horizontal load on the blade is transferred through the arm to the chassis of the skid-steer, which is best able to absorb the load (especially if the arm is resting against the chassis, as Lewis describes). In contrast, when the arm is held in a raised position by the hydraulic cylinders, the horizontal load is transferred from the blade to other components of the linkage that forms the arm assembly. The chassis—being a larger and heavier component—is better equipped to absorb the horizontal load than the (relatively) lighter and thinner arm. A POSITA would have understood that it is common sense to protect the arm assembly and its linkages by positioning the lift arm in the lowered position and against the stops on the chassis to allow the horizontal load to be transferred to the chassis rather than the pivot points or couplings of the arm assembly. *See* EX1005, 6:65-7:5 ("while the intermediate position corresponds to the lowered position, the maximum horizontal load rating of the arm/arm assembly may be further increased, as compared to a configuration in which the arm is separated from the chassis/stop, and the horizontal load is transferred from the arm to the chassis only at the arm pivot joints, and in certain embodiments, the lift cylinders").



EX1005, Fig. 2a (annotated)

106. Lewis's Fig. 2A (above) further illustrates that when the arm is in the ***lowered*** position, it ***rests against a "stop***," such that further downward movement of the arm is "blocked." *Id.*, 5:20-39; *see also* 6:59-61 ("***the arm may contact*** the chassis of the work vehicle or ***a stop coupled to the chassis of the work vehicle*** while the arm is in the lowered position"). As Lewis explains:

> As a result of the contact between the arm and the chassis/stop, a portion of the horizontal load applied to the arm by the restricted height implement may be transferred to the chassis at the point of contact. Accordingly, while the intermediate position corresponds to the lowered position, the maximum horizontal load rating of the arm/arm assembly may be further increased, as compared to a configuration in which the arm is separated from the chassis/stop, and the horizontal load is transferred from the arm to the chassis only at the arm pivot joints, and in certain embodiments, the lift cylinders.

Id., 6:61-7:5. Accordingly, Lewis's figures and description plainly teach the feature of ***positioning and resting a point of the main arm against a stop connected to the skid-steer vehicle***. Doing so maximizes the horizontal load rating.

107. To the extent Patent Owner contests the mapping analysis above, it still would have been exceedingly obvious in view of Lewis's disclosure to ***position and rest a point of the main arm against a stop connected to the skid-steer vehicle***. Lewis identifies two design options for transferring a horizontal load from the arm to the chassis—[1] positioning the arm against the chassis itself; or [2] positioning the arm against "a stop coupled to the chassis." EX1005, 6:54-7:5. It would have been well within the level of skill of the POSITA to select one of Lewis's two disclosed positions of the arm for optimizing the horizontal load, or to experiment by implementing each of the two disclosed positions. It would have been obvious to a POSITA that either of Lewis's disclosed positions would be satisfactory and would have predictably resulted in a usable skid-steer with immobilized lift arm.

108. Moreover, a POSITA would have been motivated to implement Lewis's proposal to position a skid-steer arm against a stop because doing so was a well-known solution to the equally well-known design problem of supporting the arm against external loads. EX1005, 6:54-7:5; *see also See* EX1015, 1:32-36 ("In

some prior art skid steer loaders, a separate lift arm stop is mounted to each side of the main frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"); *see also* EX1014, [0003] ("some skid steer machines have a separate lift arm stop mounted to each side of the frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"), EX1013, [0004] ("It is common for a blade of a grading system to sit level with the tracks of a vehicle on a ground surface when the vertically movable arms of the vehicle are moved to a lowermost position against stops."); EX1011, 3:27-35.

109. A POSITA would have been motivated to position the arm against a stop in the lowered position to have a well-defined point of contact and to provide a broad or reinforced contact point for the arm to prevent wear to the chassis and arms. Further, as described above, the POSITA would have understood that positioning the arm in a lowered position against a stop takes advantage of physics and structural mechanics to allow the blade to absorb a greater horizontal force as compared to having the arm raised, as Lewis teaches. EX1005, 5:20-39, 6:65-7:5 ("while the intermediate position corresponds to the lowered position, the maximum horizontal load rating of the arm/arm assembly may be further increased, as compared to a configuration in which the arm is separated from the

chassis/stop, and the horizontal load is transferred from the arm to the chassis only at the arm pivot joints, and in certain embodiments, the lift cylinders").

110. For all the reasons discussed above, a POSITA would have gleaned from Lewis's disclosure that, when the arm is in the ***lowered*** position, the arm ***rests against a stop that defines the lower limit of arm movement***. *Id.*, 5:28-33 ("the ***lowered position of the arm*** may correspond to the position of the arm while the lift cylinder(s) are fully retracted, or the position of the arm while ***movement (e.g., rotation) of the arm in a downward direction 26 is otherwise blocked*** (e.g., via contact with the chassis, ***via contact with a stop***, etc.)").

Element [1.4] preventing the ability of the main arm from providing any lifting force by restricting the ability of a hydraulic that lifts the main arm;

111. The Funk-Lewis combination renders obvious Element [1.4] and Claim 1 as a whole. For example, Lewis discloses that "[t]he controller 402 is configured to control movement of the arm by outputting a signal (e.g., a second signal) to the actuator assembly 312 [including] the ***hydraulic lift cylinder(s) 310***, ***which are configured to move the arm of the work vehicle***, and a valve assembly 314 fluidly coupled to the hydraulic lift cylinder(s) 310." EX1005, 9:34-38; *see also supra* §VI.B.2.

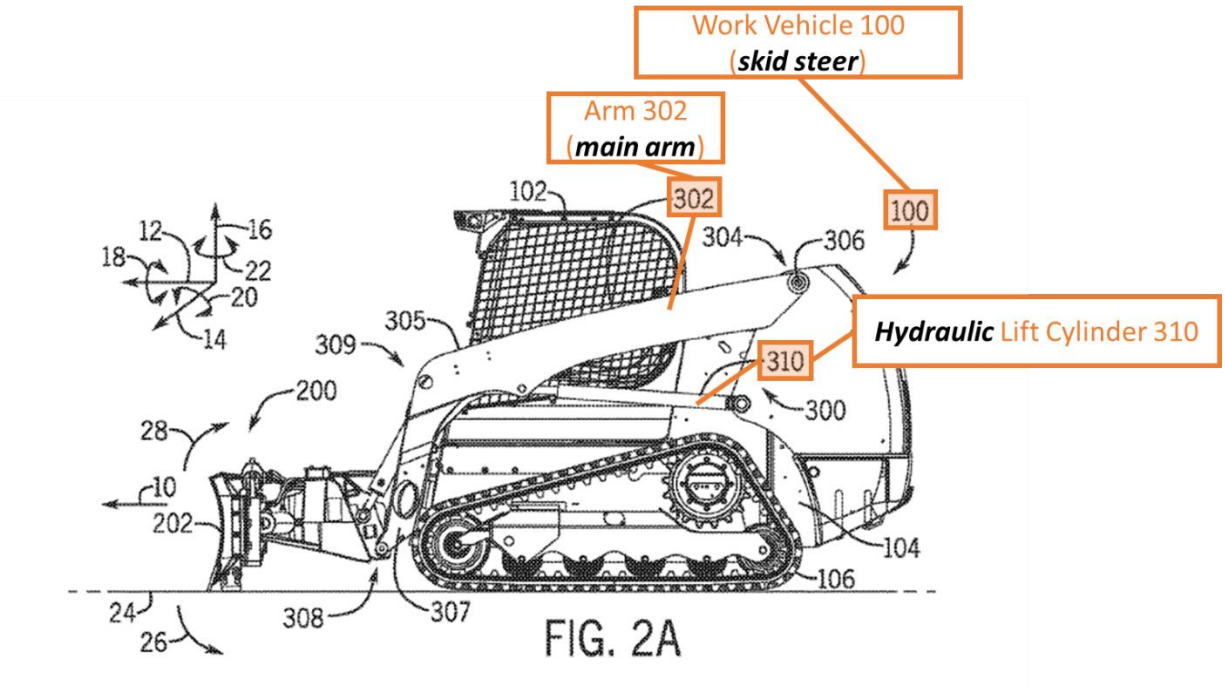


FIG. 2A

EX1005, Fig. 2a (annotated)

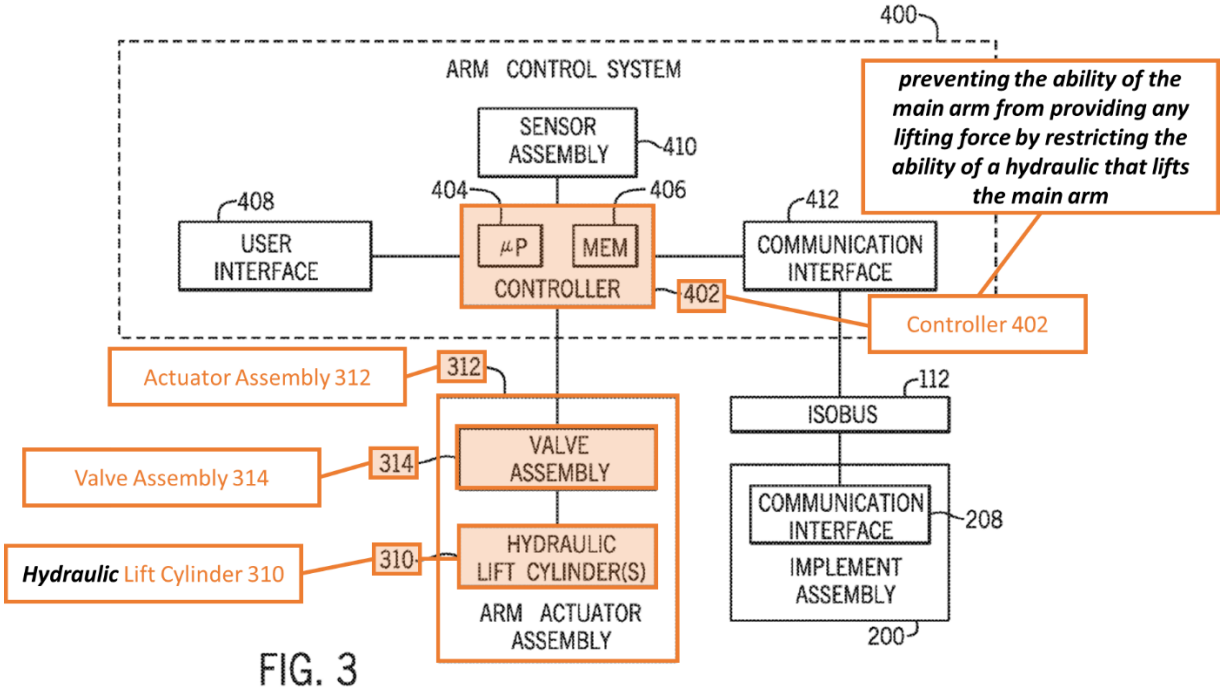


FIG. 3

EX1005, Fig. 3 (annotated)

112. Lewis discloses that "the controller 402 is configured to output a signal to the valve assembly indicative of instructions to move the arm or ***to block movement of the arm***." *Id*., 9:43-45. Lewis further discloses "***to block movement of the arm***, the controller 402 may instruct the valve assembly 314 to ***block fluid flow to and from the hydraulic lift cylinder(s) 310***." *Id.*, 9:50-53. A POSITA would have understood that blocking fluid flow to and from the hydraulic lift cylinders 310, as Lewis discloses, would restrict the ability of the hydraulic lift cylinders "which are configured to move the arm of the work vehicle." EX1005, 9:34-53. This is because blocking the fluid flow to the lift cylinders disables the ability of the lift cylinders to change the position of the arm, thus preventing any movement of the arm. *See Infra* §VI.B.3. When fluid flow to the lift cylinder is blocked by a hydraulic valve, the cylinder rod is unable to move because no fluid is moving into the cylinder and no fluid is moving out of the cylinder. Because there is no fluid flow to or from the lift cylinder, the lift cylinder is unable to move (i.e., the cylinder is "restricted" from moving) and cannot function to raise the main arm.

Element [1.5] operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface.

113. The Funk-Lewis combination renders obvious Element [1.5] and Claim 1 as a whole. As discussed at Element [1.pre], Funk provides an "***automatic***

leveling ***[grade] control system*** 100 implemented using a skid-steer 10" with a ***dozer blade*** attachment. EX1004, [0031]. *Supra* §VIII.D.1 Element [1.pre]

114. Funk's "automatic leveling [grade] control system" manipulates the dozer blade's "grading edge 26" to create a level grade by selectively actuating the hydraulic cylinder(s) that control the pitch axis of movement of the dozer blade. [3] *See* EX1004, [0014], [0033]. In particular, Funk's automatic leveling control system provides a level grade "by movement of the unit around the work surface by maintaining the working edge of the [blade] in a desired plane in relation to a laser plane projected at the worksite." *Id.*, [0014]. A laser receiver mounted on the machine (e.g., on the skid-steer) "receive[s] a laser signal from a laser plane generator associated with a predetermined level and provides a height signal" based on the laser signal.[4] *Id.*, *see also* §VI.B.2 (general description of laser automatic grading control). The machine also includes a tilt sensor for sensing "a tilt angle of the work attachment mounting structure" and "to sense a lateral tilt of the machine." EX1004, [0012]. A controller generates a control signal to control the position (e.g., a tilt angle) of the work attachment based on the height signal

[3] Funk's automatic leveling control system uses a controller to generate the control signal to adjust a height of the arm and communicate the control signal to the hydraulics. *See* EX1005, 3:4-67, 8:38-57.
[4] Although the '300 patent discusses the move toward GPS-augmented automatic grading control (EX1001, 1:55-63), claim 1 does not specify any particular type of "automatic grade control system."

received from the laser receiver and one or more tilt angle signals received from a tilt sensor. *Id.*, [0015], [0012]-[0013], [0031]-[0033].

115. Funk's automatic grade control system uses hydraulics to control blade height. EX1004, [0015] ("The controller is configured for generating a control signal based on the height signal and for communicating the control signal via DC electric current to the hydraulic valves of the machine"). For example, Funk's system generates a "control signal to the skid-steer hydraulic control controlling actuation of hydraulic cylinders 18, 28 to adjust at least one of a height of the lift arms 14 and the tilt [(pitch)] angle of the work attachment mounting structure 20 such that the grading edge 26 [(of the dozer blade)] is maintained at an elevation [(height relative to a ground surface)] substantially corresponding to the predetermined level 31 as the machine is propelled about the worksite." EX1004, [0033]; *see also* [0043] (similar), Figure 1b.

116. As illustrated below in Figure 1a, Funk's hydraulic cylinder 18 moves the main arm, and the hydraulic cylinder 28 adjusts the pitch of the dozer blade about ***a pitch axis***. EX1004, Fig. 1a, [0033]. Here, pitch axis is the pivot axis that allows the orientation of the blade to be adjusted. While Funk describes a rotation about a pivot 24, a POSITA would have understood that this adjustment is an adjustment of the pitch of the dozer blade, and that the adjustment is about a "pitch axis." EX1004, [0032]-[0033].

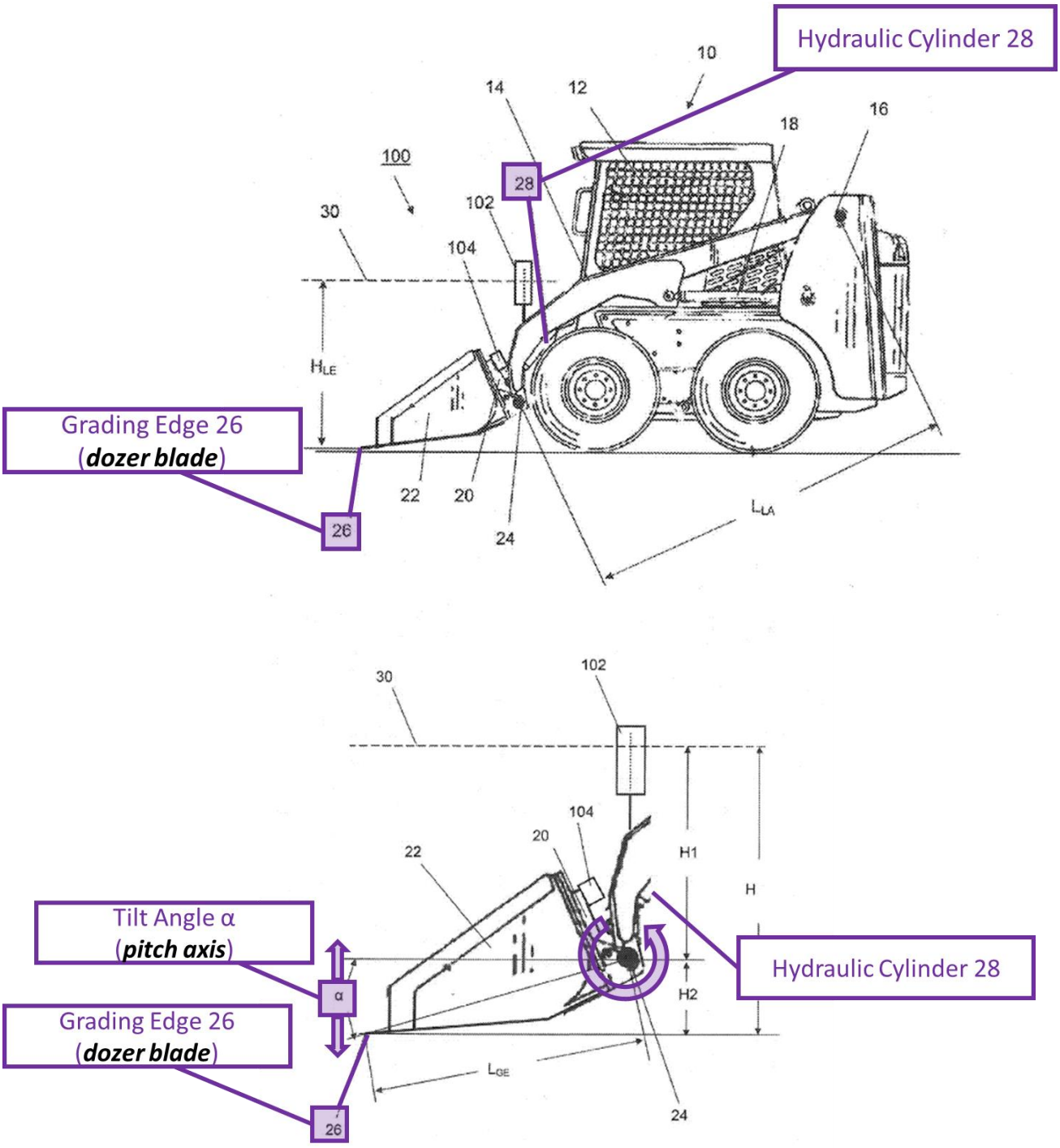
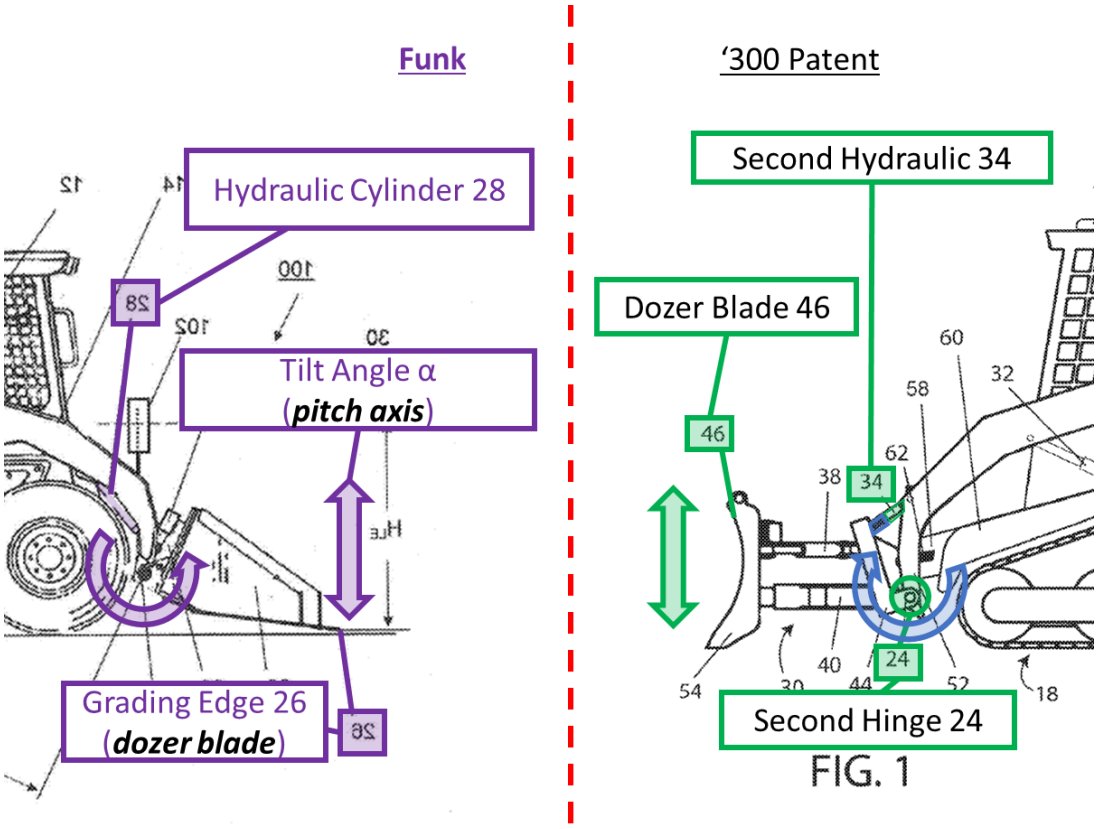


Figure. 1b

EX1004, Figs. 1a and 1b (annotated)

117. Funk describes that the controller provides a control signal to the hydraulic cylinders "to adjust at least one of a height of the lift arms 14 and the tilt angle of the work attachment mounting structure 20." EX1004, [0033]. Funk's reference to a "tilt angle" adjustable to control the position of the work implement relative to the ground is consistent with the '300 patent's reference to movement about a pitch axis. For one, the '300 patent makes clear that "pitch" movement is forward/backward "tilt." *See* EX1001, 4:33-38 (discussing the "pitch axis, or forward tilt of the dozer blade"). Funk describes that the "tilt sensor" is positioned on the work attachment mounting structure, "which is pivotally movable mounted at a pivot" of the lift arms. EX1004, [0032]. Funk's tilt sensor senses a tilt of the work implement, and Funk gives an example of "a tilt angle of the digging bucket [being] angle a between a line connecting the pivot 24 with the grading edge 26 and a [line] parallel to the laser plane 30." *Id.* A POSITA would have understood that pitch movement is a rotation about an axis—such as movement about Funk's pivot or movement about the '300 patent's pitch axis. This mapping is further confirmed by the similarity between Funk's tilt cylinder 28 and the '300 patent's pitch hydraulic 34 (see comparison below).



Left: EX1004, Fig 1a (annotated)

Right: EX1001, Fig. 1 (annotated)

118. In Fig. 1 of the '300 patent, a blade assembly attached to a vehicle is depicted, including hydraulic 34, hinge 24 and blade 46. *See* EX1001, 4:39-48. "As the hydraulic 34 picks up and lowers the blade 46 and its bottom 54 the entire blade assembly 30 is articulated about hinge 24." EX1001, 6:37-39. Just as described in the '300 patent and as illustrated in Funk's Fig. 1a above, Funk's hydraulic cylinder 28 adjusts a height of the blade by adjusting the tilt angle of the work implement (e.g., grading edge 26) about the pivot. EX1004, [0033] ("The controller 106 is configured for generating a control signal based on the

height signal, the tilt angle signal and the lateral tilt signal and for communicating the control signal to the skid-steer hydraulic control controlling actuation of hydraulic cylinders 18, 28 to adjust at least one of a height of the lift arms 14 and the tilt angle of the work attachment mounting structure 20 such that the grading edge 26 is maintained at an elevation substantially corresponding to the predetermined level 31 as the machine is propelled about the worksite"), [0032].

119. In the Funk-Lewis combination, the main arms are held still, leaving the pitch axis hydraulic as the lone means by which blade height is controlled. *See Infra* §VII.C; EX1004, [0033], [0043]; EX1005, 5:20-39, 6:54-7:5. Funk discloses that the controller generates the control signal and communicates the control signal to the hydraulic control. *See* EX1004, [0033] ("The controller 106 is configured for generating a control signal…and for communicating the control signal to the skid-steer hydraulic control controlling actuation of hydraulic cylinders 18, 28 to adjust at least one of a height of the lift arms 14 and the tilt angle of the work attachment mounting structure 20"). Only by coupling Funk's automatic grade control system to the hydraulic system would the controller be able to issue the control signals to the hydraulic cylinders to adjust the blade. Given that the automatic grade control system issues control instructions—or control signals—for actuating the pitch axis hydraulic, a POSITA would have understood that the

system is ***operably connected*** to the hydraulic system. EX1004, [0015], [0016], [0033], [0043]; *see also supra* §§VI.B.2-3.

2. Claim 2

Element [2.pre] The method for controlling a dozer blade as in claim 1 further including:

Element [2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

120. The Funk-Lewis combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole, including for similar reasons discussed above at §VIII.D.1 Elements [1.2], [1.3], and [1.4]. For example, Lewis's controller blocks movement of ***the main arms (locking them in place) at a lower limit of movement*** that is ***against the stop*** by outputting a signal to the valve assembly to block fluid flow to and from the hydraulic lift cylinders that would otherwise move the arm. EX1005, 5:20-39, 6:54-7:5, Fig. 2a; *see also supra*, §VIII.D.1 Elements [1.2], [1.3], [1.4].

121. As described above, Lewis's signal blocking the flow of hydraulic fluid to and from the hydraulic lift cylinders prevents the cylinders from moving and thus prevents the cylinder from moving the lift arm. *See Infra* §VIII.D.1 Element [1.4]; *see also* §VI.B.3; EX1005, 5:20-39, 6:54-7:5. Because the hydraulic lift cylinders are prevented from moving, the arm is held stationary against the stop and is effectively locked in place. EX1005, 5:20-39, 6:54-7:5.

3. Claim 3

Element [3.pre] The method for controlling a dozer blade as in claim 1 further including:

Element [3.1] operating a valve to hydraulically isolate the hydraulic lift that lifts the main arm to further prevent any movement of the main arm.

122. The Funk-Lewis combination renders obvious Elements [3.pre] and [3.1] and Claim 3 as a whole, including for similar reasons discussed above at §VIII.D.1 Element [1.2], [1.3], and [1.4]. As discussed, Lewis's controller blocks arm movement (***prevents movement of the arm***) by outputting a signal to the valve assembly to block fluid flow to and from the hydraulic lift cylinders that would move the arm. *Supra*, §VIII.D.1 Elements [1.2], [1.3], [1.4]; *see also* §VI.B.3; EX1005, 9:34-53, Figs. 2a and 3. Lewis describes that the system includes "hydraulic lift cylinder(s) 310, which are configured to move the arm of the work vehicle, and a valve assembly 314 fluidly coupled to the hydraulic lift cylinders [and] configured to control fluid flow…to the lift cylinder(s)." EX1005, 9:37-42.

123. From a POSITA's perspective, it would have been apparent or obvious to operate Lewis's valve assembly by using the controller to output a signal to ***operate a valve***, as claimed. Indeed, this understanding finds support in Lewis's disclosure that the controller "is configured to output a signal to the valve assembly indicative of instructions to move the arm or to block movement of the arm." EX1005, 9:34-53, Fig. 3; *see also infra* §VI.B.3. Hydraulic control systems utilize valves to control the flow of hydraulic fluid to and from a hydraulic

cylinder—e.g., the valves are used in the control of the movement of the cylinder. *See infra* §VI.B.3. For example, operation of the valve is often accomplished by transmitting a control signal to move a spool within the valve, the position of the spool dictating hydraulic fluid flow through the valve. In the context of Lewis's disclosure, a POSITA would have understood the controller's signal to the valve assembly to be a signal operating a valve of the assembly, such as by setting a spool position, and therefore controlling whether/how fluid flows to or from the hydraulic lift cylinder. EX1005, 9:34-53 (describing instructions from the controller to the valve assembly to "enable fluid flow to a cap end" or "to a rod end" to control a movement of the hydraulic lift cylinder and arm); *see also infra* §VI.B.3. The POSITA would have applied this understanding to Lewis's description that "to block movement of the arm, the controller 402 may instruct the valve assembly 314 to block fluid flow to and from the hydraulic lift cylinder(s)." EX1005, 9:50-53.

124. It would have also been obvious to a POSITA that blocking fluid flow to and from the hydraulic lift cylinders results in ***hydraulically isolating*** the cylinder, and therefore preventing actuation or motion of, the ***hydraulic lift that moves the main arms***. By controlling the valve to block the flow of hydraulic fluid to or from the hydraulic lift cylinder, no fluid can move into or out of the hydraulic lift cylinder. The hydraulic lift cylinder is thus "isolated" in that there is

no fluid that is coming in or moving out of the lift cylinder, and no motion of the cylinder can occur. When the cylinder is unable to move (because there is no flow of hydraulic fluid in or out of the cylinder), the cylinder cannot provide a moving force to the equipment that it typically moves—in this case the lift arm. A POSITA would have recognized that blocking the fluid flow to or from the hydraulic cylinder isolates the cylinder from hydraulic fluid flow in or out of the cylinder, preventing movement of the cylinder and thus preventing movement of the arm that the cylinder is configured to actuate, and therefore immobilizing and effectively locking the arm in place.

4. Claim 4

Element [4.pre] The method for controlling a dozer blade as in claim 3 further including:

Element [4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

125. The Funk-Lewis combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §VIII.D.1 Elements [3.1] and [2.1].

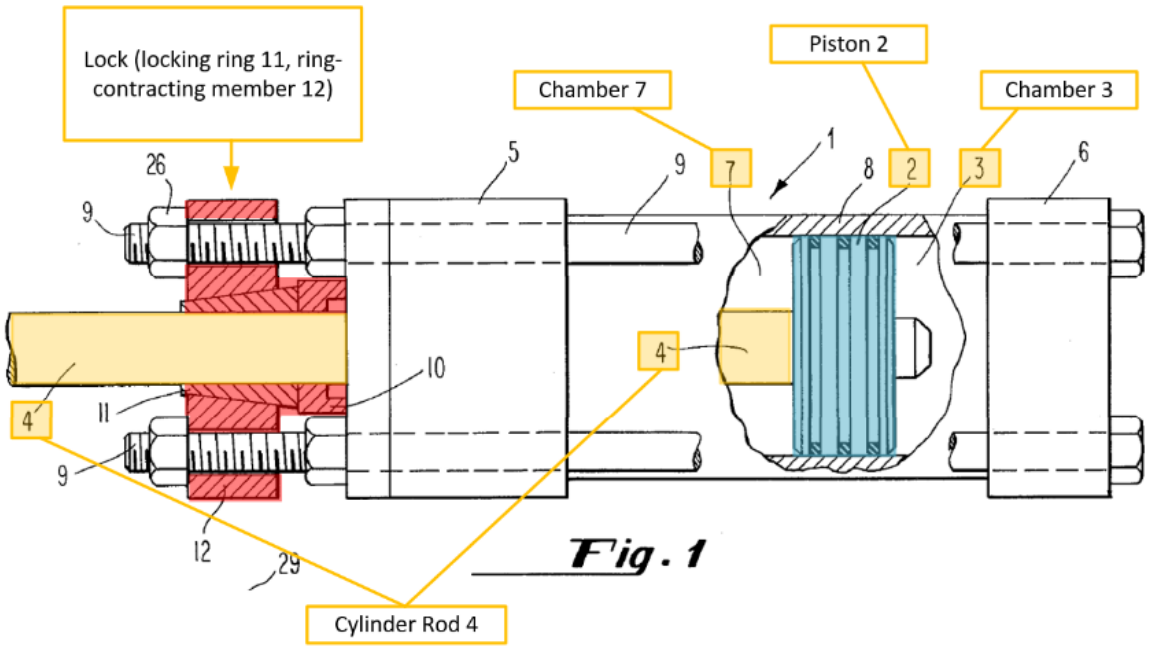
IX. GROUND 1B—OBVIOUSNESS OVER FUNK, LEWIS, STRATIENKO

126. Ground 1B is substantively identical to, and incorporates the analysis of Ground 1A, for several claim elements. Stratienko's supplementary teachings provide an additional/alternative basis for finding Element [1.4] and Claims 2-4

satisfied and obvious in view of the claims as a whole. Integrating Stratienko's supplementary teachings with respect to Elements [1.4], [2.1], [3.1], and [4.1] here in Ground 1B does not disturb the aspects of Funk and Lewis mapped to the other claim elements in Ground 1A.

A. Stratienko (EX1008)

127. Stratienko describes a "mechanical locking device for locking a rod in a conventional hydraulic actuator, such as a hydraulic cylinder." EX1008, Abstract. Stratienko's "rod locking device" includes a "radially contractible locking ring having a cylindrical inner surface for gripping the [cylinder] rod when the locking ring is contracted" in response to an "axial biasing force." EX1008, 2:33-54; *see also* 3:50-4:36. Stratienko further explains that "the rod locking device is capable of automatic operation" where the locking ring "is engaged and disengaged through hydraulic pressure means," such as an "automatically controlled valve" that governs the applied axial force and its timing by regulating the pressure in a hydraulic chamber. EX1008, 2:55-66, 5:14-6:30, Figures 3-4.



EX1008, Fig. 1 (annotated)

128. Like the operation of other hydraulic cylinders, in Stratienko's system illustrated in Figure 1 (above), pressurized hydraulic fluid is applied to either chamber 3 or to chamber 7 to cause movement of the piston 2 and the cylinder rod 4 either inward or outward depending on which chamber is pressurized and which chamber is vented to allow fluid to escape from the chamber. EX1008, 3:28-40. In turn, rod 4 moves and passes through the cylinder head 5 thus transferring the resulting "work force" from the hydraulic cylinder. EX1008, 3:41-49.

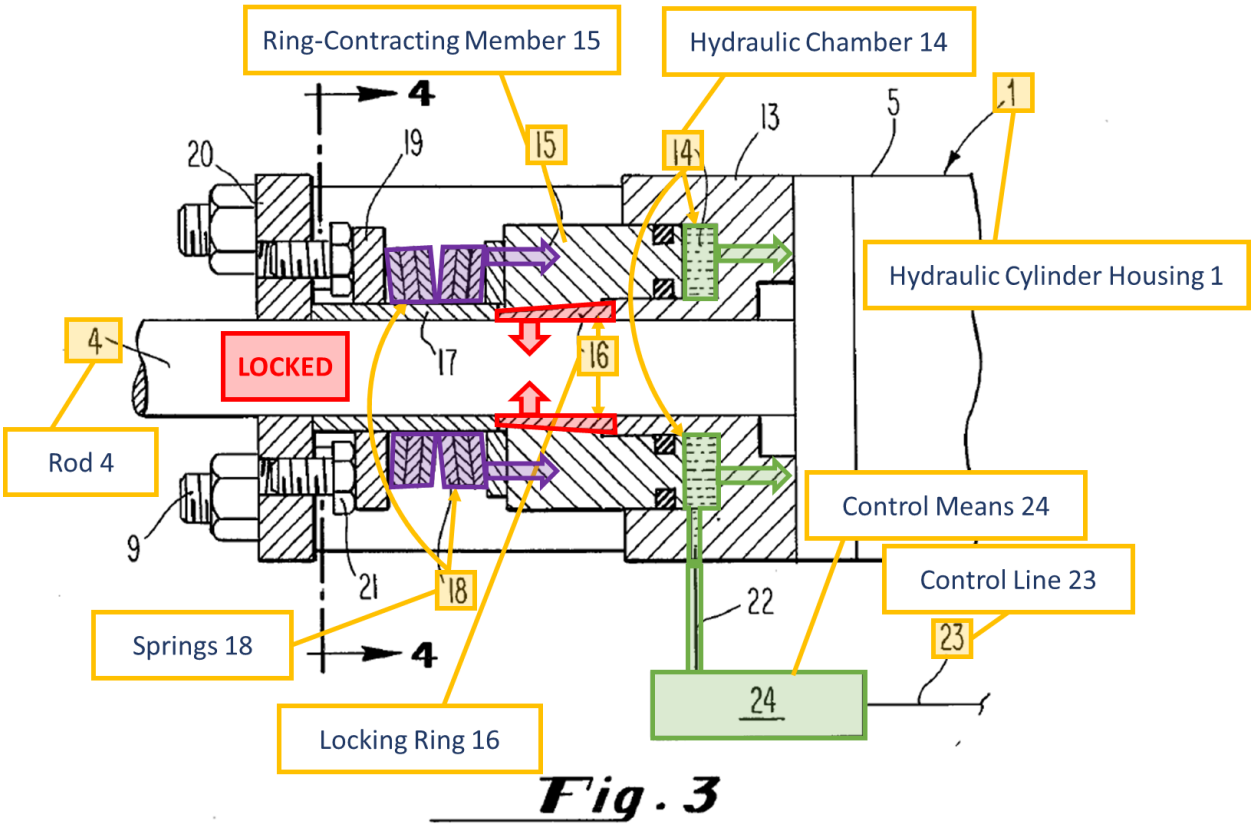


Fig. 3

EX1008, Fig. 3 (annotated)

129. The rod locking device of the Stratienko invention is illustrated in Figure 1 and an embodiment in which the locking device "is engaged and disengaged through hydraulic pressure means" is shown in more detail in Figure 3 (both reproduced above). In Figure 1, Stratienko's rod locking device is accomplished with locking ring 11 and ring-contracting member 12, working with "sleeve 10 which secures the locking ring 11 against axial movement towards the cylinder housing 1 and [provides a] means for applying an axial force to the ring-contracting member 12." *Id.*, 3:50-55. In the locking device of Figure 1, "the axial force applying means is accomplished by tightening nuts 26 on bolts 9, which are

extended beyond the cylinder head 5 so that nuts 26 can be tightened against ring-contracting member 12." *Id.*, 3:55-59. "Sleeve 10 provides a flat surface for locking ring 11 to fit firmly against." *Id.*, 3:59-60. Locking ring 11 includes a slot and is therefore radially contractible and also capable of returning to its expanded size once the contracting force is released. *Id.*, 3:66-4:1, 4:21-29. Spaced holes in the ring-contracting member 12 allow passage of bolts 9. *Id.*, 4:12-13. "Nuts [26] on bolts 9 are tightened to push ring-contracting member 12 towards cylinder head 5," which causes locking ring 11 to contract and grip rod 4" thus locking the rod in place. *Id.*, 4:13-20. This prevents movement of rod 4 both inward and outward until the "nuts 26 are backed off to relieve the axial force exerted on ring-contracting member 12." *Id.*, 4:18-20. It should be noted that "locking ring 11 is designed to be self-releasing so that it automatically pushes ring-contracting member 12 back away from cylinder head 5 when the axial force is released, and [thus] loosens its grip on rod 4" and allows for normal operation of the hydraulic cylinder to move the rod 4 inward and outward. EX1008, 4:21-24. Stratienko's device depicted in Figure 3 (reproduced and annotated above) shows an embodiment in which "[t]he means for moving the ring-contracting member … is engaged and disengaged though hydraulic pressure means." *Id.*, 5:9-18. In the embodiment of Figure 3, the locking ring 16 is positioned around the rod, and "[s]prings 18 are positioned … against ring-contracting member 15." *Id.*, 5:28-31.

"By proper preadjustment of the axial biasing force from spring 18, the release of pressure in hydraulic chamber 14 results in the automatic axial movement of ring-contracting member 15 towards the cylinder housing 1 (direction of axial inclination of the outer surface of locking ring 16) and contracting of locking ring 16." *Id.*, 5:54-59. As a result, "the rod 4 is instantly and automatically locked in position if pressure is inadvertently lost in the hydraulic cylinder." *Id.*, 5:60-62.

130. According to Stratienko, the locking device is "universally adaptable to standard hydraulic actuators," including "hydraulic cylinders [that] are capable of exerting very large forces, [such as] hundreds of thousands of pounds." EX1008, 2:67-3:9, 3:28-49. The locking device also "provides the advantage of infinite position locking"—meaning it can lock the hydraulic cylinder rod "at any point of stroke"—"yet is compact, simple, and inexpensive." EX1008, 2:67-3:9, 1:62-63.

B. The Funk-Lewis-Stratienko Combination

131. The Funk-Lewis-Stratienko combination represents the predictable result of applying Stratienko's supplemental teachings about an infinite position mechanical locking device for selectively preventing movement of a hydraulic cylinder rod to the Funk-Lewis combination, which provides for immobilizing the main lift arm of a skid-steer in a lowered position during automatic grading. In effect, Stratienko's device provides a mechanism for mechanically locking the

hydraulic cylinder rod that, in turns, controls and prevents movement of the skid-steer's main lift arm in the Funk-Lewis combination. In this combination, Stratienko's teaching to use an infinite position mechanical lock to prevent movement of the hydraulic cylinder rod is combined with the teachings of Funk-Lewis (described above). I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other.

1. Reasons to Combine

132. From a POSITA's perspective in 2018, applying Stratienko's supplemental teachings in this way would have involved nothing more than applying a known mechanical solution to the known mechanical problem of preventing "undesirable movements of the rod," (EX1008, 1:22-27)—a problem suggested by Lewis's teaching to "[b]lock upward movement of the arm," EX1005, 4:34-5:6. A POSITA would have understood that combining known mechanical systems provides predictable and reliable results. The fundamental aspects of Funk's disclosure would remain intact, bolstered by the well-known and beneficial teachings of Lewis to block movement of the hydraulically-driven main arm and Stratienko to prevent movement of a hydraulic cylinder, thereby arriving at the '300 patent's claimed invention.

133. A POSITA would have been motivated to pursue the Funk-Lewis-Stratienko combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

a. Preventing Undesirable Movements

134. Lewis's teaching to block movement of the skid-steer main arm driven by a hydraulic cylinder would have prompted a POSITA to look to references, such as Stratienko, that disclose solutions to the problem of preventing "undesirable movements" of a hydraulic cylinder rod. EX1008, 1:22-27; EX1005, 4:34-5:6, 9:34-53. Lewis's teaching to use hydraulic controls to "block" movement of the lift arm to maximize the load rating of the lift arm and arm assembly would have prompted the POSITA to look for other means to prevent movements of the lift arms. EX1005, 4:34-5:6. A POSITA would have appreciated that Stratienko provides just such a mechanism "for locking a rod in a conventional hydraulic actuator." EX1008, Abstract, *see also* Title ("Locking device for hydraulic actuator").

135. A POSITA would have understood that locking a cylinder rod is a known technique for solving the problem that Lewis's teaching introduces—to prevent movement of the main arm. Stratienko describes multiple reasons "to lock the driven rod in a hydraulic actuator" including "to avoid small, but undesirable[,] movements of the rod due to leaking of hydraulic fluid past the seals within the

actuator or because of compressibility of the hydraulic fluid." EX1008, 1:22-27; *see also supra* §VI.B.4. Stratienko contrasts the infinite position lock with "[c]onventional locking devices." *Id.*, 1:27-28. A POSITA would have further understood that methods for locking a hydraulic cylinder in a position fall into the categories of either mechanical or hydraulic locks, just as Stratienko teaches. EX1008, 1:21-34 ("Conventional locking devices are generally either the mechanical type or the hydraulic type"). Stratienko describes that a "third type of mechanical locking device is the infinite position type which locks at any point of stroke" and "has the broadest application possibilities." *Id.*, 1:62-64.

b. Easily Implemented Solution to the Problem

136. A POSITA would have understood that Stratienko's mechanical cylinder lock presents a suitable solution to the main-arm-immobilization problem—either in place of or in conjunction with Lewis's suggestion to block hydraulic fluid flow—because Stratienko's cylinder lock is specifically designed to work with large, high-capacity (in terms of both output force and power) hydraulic cylinders, such as those on a skid-steer. EX1005, 9:34-53; EX1008, 2:67-3:9, 3:28-49, 2:33-39. A POSITA would have understood from Stratienko's description that the cylinder lock is compatible with hydraulic cylinders that would be used in a skid-steer to raise and lower the lift arm. In fact, in the "Field of Invention" section of Stratienko's patent, it is specifically stated that "[t]he present

invention relates to hydraulic actuators of the type used to exert large forces." EX1008, 1:13-14.

137. Additionally, Stratienko's lock can be engaged at any point of the cylinder stroke, including when the cylinder is contracted and the lift arm is in the lowered position, even in the lowest position. Stratienko describes that the "ring-contracting member is preferably designed to withstand the rod force so that it can lock the rod against movement in either direction." EX1008, 6:59-62. A POSITA would have appreciated from Stratienko's description that the cylinder lock (and its ring-contracting member) would be used to block movement of the cylinder rod to keep the lift arm in the lowered position. A POSITA would have been motivated to use Stratienko's lock for this purpose as a suitable addition to the Funk-Lewis design to prevent the main arm from moving.

c. Known and Predictable Advantages

138. A POSITA would have appreciated that there are particular advantages to using Stratienko's lock in the Funk-Lewis combination. First, while Lewis describes the idea of hydraulically isolating the cylinder to keep it from moving (EX1005, 9:34-53), Stratienko recognizes that fluid leak across the seals could still cause unwanted movements of the arm. EX1008, 1:22-27. As described above, the leakage of fluid through the seals of the valves and the compressibility of hydraulic fluid can lead to small but unwanted movements of

the hydraulic cylinder rod, even when hydraulic controls are used to prevent or block movement. *Supra* §VI.B.4. A POSITA would have understood that during grading operations, any inadvertent movement of the vehicle arm caused by fluid leak would move the blade relative to the ground and cause the resulting grading to be out of specification. More specifically, a POSITA would have known and expected the forces exerted on the grading blade during interaction of the blade with the ground in a grading operation to be comprised of both horizontal and vertical components. The horizontal force would be in the opposite direction of the vehicle propulsion force, and the vertical (upward) force would be opposed by the forces exerted on the skid-steer arms. Grading in the presence of these typical components of loading and undesirable grading blade movement scenarios would be inefficient and costly because areas may need to be re-graded if the inadvertent arm movements (such as up and down movements of the arms made possible by hydraulic fluid leakage or compressibility) cause the grading to deviate too far from the requirements for the site. EX1004, [0002] ("the ground has to be leveled with high accuracy").

139. Further, a POSITA would have understood that while Lewis's hydraulic control may be susceptible to fluid leakage within the valve that would allow some movement of the cylinder and lift arm, Stratienko's mechanical lock has no such susceptibility. *See* §V.B.4, *supra*. A mechanical lock—such as the

cylinder lock Stratienko teaches—solves the problem of movements due to fluid leakage, as well as others that would arise due to inadvertent lift arm movements. For example, locking the lift arm in a position with Stratienko's cylinder lock would prevent grading inaccuracies that may result from the small and unwanted movements of the arm. Additionally, locking the lift arm in a position with Stratienko's cylinder lock would prevent unpredictable movement of the lift arm and objects on the ground that might be impacted by the arm during small arm movements, such as stones.

140. Second, Stratienko describes that mechanical locks are durable, and that his specific design is compact, simple, and inexpensive. EX1008, 1:29-31; 2:3-6; 2:67-3:1. A POSITA reading Stratienko would have understood that the lock would be easily installed and economically manufactured because of its simple design. Further, Stratienko describes that the cylinder lock "is used in conventional hydraulic actuators" (id., 2:34-35) and "is universally adaptable to standard hydraulic actuators and can be easily adapted to fit different size rods for a particular hydraulic actuator." *Id*., 3:3-6. By providing a lock that can be used with existing hydraulic actuators, Stratienko's lock would be applied to vehicles in the field without any need to retrofit or otherwise upgrade the vehicle. A POSITA would have appreciated that applying Stratienko's teaching of a simply installed

and inexpensive lock would be straightforward and would be well-worth the expected outcome of blocking even minor movements of the lift arm.

141. Accordingly, a POSITA would have been motivated by such advantages to use Stratienko's lock teaching with the Funk-Lewis design to prevent inadvertent movement of the arm. A POSITA would have appreciated that instead of, or in addition to, using Lewis's hydraulic control system to keep the arm on the chassis stop, the cylinder lock taught by Stratienko would have been used to the same or similar effect. Additionally, a POSITA would recognize that this mechanical and hydraulic combination will produce predictable results with known performance.

C. Claim Element Analysis

1. Claim 1

Element [1.pre] A method for controlling a dozer blade controlled by an automatic grade control system on a skid steer vehicle comprising:

Element [1.1] providing a skid steer vehicle having a main arm with a front side operably coupled to a dozer blade assembly;

Element [1.2] providing a stop connected to the skid steer vehicle upon which a point of the main arm rests thereby defining a lower limit of movement of the main arm;

Element [1.3] positioning the point of the main arm against the stop;

142. The Funk-Lewis-Stratienko combination renders obvious Elements [1.pre], [1.1], [1.2] and [1.3] and Claim 1 as a whole for the same reasons discussed above at §VIII.D.1 (Discussion of Elements [1.pre], [1.1], [1.2], [1.3]).

Element [1.4] preventing the ability of the main arm from providing any lifting force by restricting the ability of a hydraulic that lifts the main arm;

143. The Funk-Lewis-Stratienko combination renders obvious Element [1.4] and Claim 1 as a whole. As discussed, this combination incorporates Stratienko's disclosure of an automatically operated "infinite position type" mechanical hydraulic cylinder rod lock as a supplemental means of immobilizing the main arm of the Funk-Lewis skid-steer vehicle in a lowered position against a mechanical stop. EX1008, 1:62-63; *see also id.*, 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §IX.B.1 (motivation-to-combine). The infinite position lock ***prevents movement of the hydraulic cylinder*** rod thus ***restricting its ability to move*** the lift arm and ***preventing any movement*** (such as a lifting force) ***of the lift arm***.

144. Accordingly, as a POSITA would have understood, in the Funk-Lewis-Stratienko combination, when Stratienko's mechanical lock grips the rod of the hydraulic cylinder thus controlling the main arm, the ***main arm is prevented from providing any lifting force*** because the ***hydraulic that lifts the main arm is restricted*** from moving. §IX.B (combination); *see also supra* §VI.B.3.

Element [1.5] operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface.

145. The Funk-Lewis-Stratienko combination renders obvious Element [1.5] and Claim 1 as a whole for the same reasons discussed above at §VIII.D.1 (Discussion of Element [1.5]).

2. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

146. The Funk-Lewis-Stratienko combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole. As discussed, this combination incorporates Stratienko's disclosure of an "infinite position type" mechanical hydraulic cylinder rod lock for immobilizing the main arm of the Funk-Lewis skid-steer vehicle in a lowered position against a mechanical stop. EX1008, 1:62-63; *see also id.*, 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §IX.A.1 (motivation-to-combine). As a POSITA would have understood, in the Funk-Lewis-Stratienko combination, Stratienko's infinite position lock prevents the rod of the hydraulic cylinder from axial movement so that there is no extension or retraction of the rod. Without extension or retraction of the hydraulic cylinder rod, there is no movement of the lift arm because the hydraulic cylinder rod is not operable to raise or lower the lift arm from its

position. Stratienko's infinite position lock thus locks the main arm in place by preventing the main arm from moving. EX1008, 5:40-62. Accordingly, a POSITA would have understood that in the Funk-Lewis-Stratienko combination, engaging Stratienko's mechanical hydraulic cylinder rod lock ***locks the main arm against the stop*** at the ***lower limit of movement of the main arm***.

3. Claim 3

[3.pre] The method for controlling a dozer blade as in claim 1 further including:

[3.1] operating a valve to hydraulically isolate the hydraulic lift that lifts the main arm to further prevent any movement of the main arm.

147. The Funk-Lewis-Stratienko combination renders obvious Elements [3.pre] and [3.1] and Claim 3 as a whole, including for similar reasons discussed above at §VIII.D Elements [1.2], [1.3], and [1.4]. As discussed, this combination incorporates Stratienko's disclosure of an automatically operated "infinite position type" mechanical hydraulic cylinder rod lock as a supplemental means of immobilizing the main arm of the Funk-Lewis skid-steer vehicle in a lowered position against a mechanical stop. EX1008, 1:62-63; *see also id.*, 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §IX.B (motivation-to-combine).

148. In the Funk-Lewis-Stratienko combination, a POSITA would have been motivated to apply Stratienko's cylinder lock ***in addition to*** Lewis's instructions to block fluid flow to or from the hydraulic cylinder that controls the

main arm. EX1005, [0036]; *supra* §VIII.B (summary of Lewis), §IX.B.1 (motivation-to-combine), §VI.B.5 (explaining that it was conventional to employ redundant mechanisms at jobsites for a variety of reasons). Locking the hydraulic cylinder rod to prevent any movement of the cylinder, based on Stratienko's teaching of the infinite position lock, prevents the small and unwanted movements of the hydraulic that can occur when there is leakage around the valve. Stratienko's cylinder lock provides an additional mechanism for preventing movements of the lift arm, taking into account the realities of hydraulic systems of which a POSITA would have been well-aware. *See supra* §VI.B.2-3. A POSITA, knowing that leakage of hydraulic fluid can occur, would have been motivated to implement Stratienko's cylinder lock with Lewis's hydraulic control to block movement of the main arm during grading operations.

149. As explained above, a POSITA would have understood that blocking hydraulic fluid flow to and from the hydraulic cylinder might still lead to unintentional movements when fluid leaks across seals in the system and would have been motivated to employ both hydraulic and mechanical locks as a result. EX1008, 1:22-27; *see also supra* §VI.B.3. It would have also been obvious to a POSTA that blocking fluid flow to and from the hydraulic lift cylinders results in ***hydraulically isolating*** the cylinder, and therefore preventing actuation of, the ***hydraulic lifts that moves the main arms***. As discussed, Lewis's controller blocks

arm movement (***prevents movement of the arm***) by outputting a signal to the valve assembly (***operating a valve***) to block fluid flow to and from the hydraulic lift cylinders that would move the arm (***hydraulically isolate the hydraulic lift that lifts the main arm***). *Supra*, Elements [1.2], [1.3] and [1.4]; EX1005, [0036], Figs. 2a and 3; *supra* §VI.B.3.

150. A POSITA would have understood that there is little downside to using Stratienko's lock as an additional locking mechanism in the Funk-Lewis-Stratienko combination because Stratienko's lock can be used with any standard cylinder and is both cheap and easy to install. EX1008, 1:29-31; 2:3-6; 2:67-3:1. From a POSITA's perspective, it would have been apparent or obvious to operate Lewis's valve assembly using the controller to output a signal to ***operate a valve***. EX1005, [0036], Fig. 3. It would have also been obvious to a POSTA that blocking fluid flow to and from the hydraulic lift cylinders results in ***hydraulically isolating*** the cylinder, and therefore preventing actuation of, the ***hydraulic lifts that moves the main arms***. Accordingly, a POSITA would have appreciated that in the Funk-Lewis-Stratienko combination, Lewis's controller ***operates a valve assembly*** to block fluid flow to and from the hydraulic lift cylinders resulting in ***hydraulically isolating*** the cylinder and therefore preventing actuation of the ***hydraulic lifts that moves the main arm***.

151. It would have further been obvious to a POSITA to utilize ***both*** mechanical locking systems (like Stratienko's cylinder lock) and hydraulic locking mechanisms (like Lewis's hydraulic control system) to prevent the movement of the arm during grading to efficiently perform required grading work. A POSITA would have understood that additional and separate mechanisms are applied to important systems as a matter of routine practice for a variety of reasons, including to improve performance, to increase efficiency, to improve safety, and to ensure continued operation of equipment in the case of failure (minimizing lost time or cost due to equipment being inoperable). *Supra* §VI.B.5.

152. Generally, depending on the worksite and where possible, multiple (often redundant) mechanisms are used to prevent disruption of workflow and improve the efficiency of the work. In some environments or worksites, using more than one mechanism to lock a lift arm in place can provide redundancies that protect against failure or prevent operator error or oversight. When an additional and separate mechanism is easy and economical to implement, as is the case with Stratienko's lock, a POSITA would have been motivated to incorporate it as a matter of routine. EX1008, 1:29-31; 2:3-6; 2:34-35; 2:67-3:1; 3:3-6.

153. Additionally, in some worksites, separate mechanisms can also be used to provide alternative means of ensuring that equipment remains operational in case of failure of a first mechanism. The presence of equipment and operators at

a worksite can be costly, and, when equipment fails and requires repair, the equipment cannot be operated at the worksite, resulting in slow-downs in accomplishing the job at the worksite. *Supra* §VI.B.5. As a general matter, in situations where it is possible that components of worksite equipment may break and render the equipment inoperable, it is generally considered good practice to have a backup or replacement of the equipment, component, or other device/mechanism that prevents long periods of downtime. By providing multiple mechanisms for keeping the lift arm from moving from a lowered position, a POSITA would have understood that in the case of a failure of one of the mechanisms, work could continue relying on the second mechanism. Grading at the worksite could continue and the project could remain on schedule despite the failure of one system. By incorporating redundancies, in some cases and depending on circumstances and the particularities of the worksite, disruption in workflow can be avoided or alleviated. Accordingly, in the Funk-Lewis-Stratienko combination, Stratienko's cylinder lock would be used to provide a mechanical lock to prevent the movement of the arm ***and*** Lewis's hydraulic control system would also be used to isolate the hydraulic lift to further prevent any undesirable movement of the arm.

154. A POSITA would have appreciated that in the Funk-Lewis-Stratienko combination, Lewis's controller ***operates a valve*** assembly to block fluid flow to

and from the hydraulic lift cylinders resulting in ***hydraulically isolating*** the cylinder and therefore preventing actuation of the ***hydraulic lifts that moves the main arms***. *Supra* §VIII.D Element [3.1], §VI.B.3.

4. Claim 4

Element [4.pre] The method for controlling a dozer blade as in claim 3 further including:

Element [4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

155. The Funk-Lewis-Stratienko combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §IX.C Elements [3.1] and [2.1].

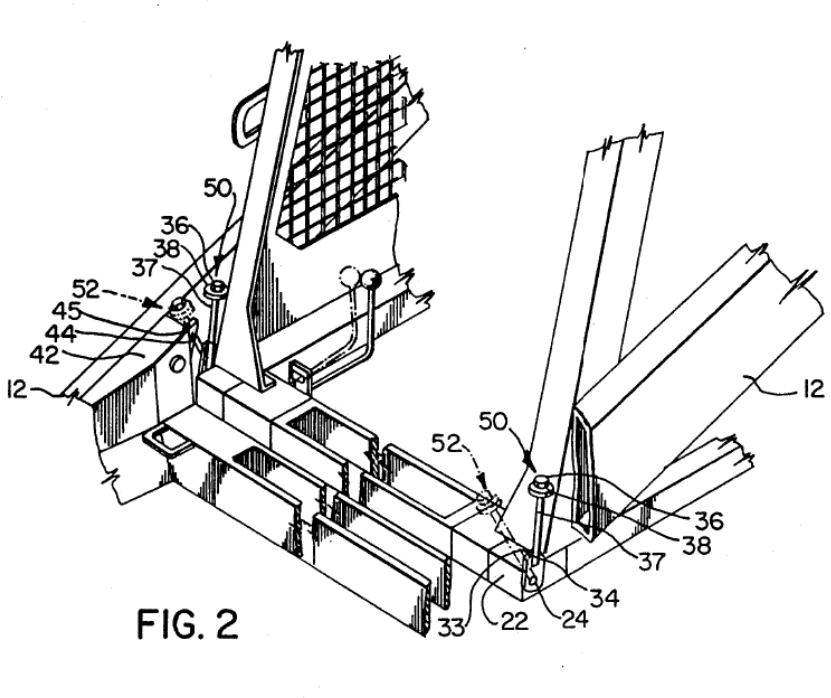
X. GROUND 1C—OBVIOUSNESS OVER FUNK, LEWIS, ORSER

156. Ground 1C is substantively identical to, and incorporates the analysis of Ground 1A, for several claim elements. Orser's supplementary teachings provide an additional/alternative basis for finding Elements [2.1] and [4.1] satisfied and obvious in view of the claims as a whole. Integrating Orser's supplementary teachings with respect to Elements [2.1] and [4.1] here in Ground 1C does not alter the features of Funk and Lewis mapped to the other claim elements in Ground 1A.

A. Orser (EX1009)

157. Orser describes a "lift arm lock down apparatus for a load lifting vehicle." EX1009, Abstract. Specifically, Orser mentions that the lock is

employed to secure "one or more lift arms of a front end loader…in ***a lowered position***." EX1009, 1:6-11. (emphasis added). Orser's lock accomplishes this goal by manually locking "the lift arm to the vehicle body, when lowered." EX1009, 2:30-36. An operator moves the locking device into position when the arms are lowered to engage a manual lock that prevents movement of the lift arms in a vertical direction. EX1009, 4:19-39 (". . . an upward movement of lift arm 12 with respect to vehicle body 16 is prevented.").



EX1009, Fig. 2

B. The Funk-Lewis-Orser Combination

158. The Funk-Lewis-Orser combination represents the predictable result of applying Orser's supplemental teachings about a mechanical lift arm lock to the

Funk-Lewis combination, which provides a hydraulic locking mechanism for immobilizing the main arm of a skid-steer in a lowered position during automatic grading. *See supra* §VIII.C. In effect, Orser's device provides a mechanism for mechanically locking the skid-steer's main arm to the stop on the skid-steer chassis in the Funk-Lewis combination. EX1009, 2:9-14. In this combination, Orser's teaching to use mechanical lock to lock the lift arm to the stops is combined with the teachings of Funk-Lewis (described above). I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other.

1. Reasons to Combine

159. From a POSITA's perspective in 2018, applying Orser's supplemental teachings in this way would have involved nothing more than applying a known solution to the known problem of preventing movement of the main arm—a problem suggested by Lewis's teaching to "[b]lock upward movement of the arm." EX1005, 4:34-5:6. A POSITA would have been aware of mechanical locks as a known method for fixing a moving component in place and would have been motivated to apply this known method to the known issue of unwanted lift arm movement. The fundamental aspects of Funk's disclosure would remain intact, bolstered by the well-known and beneficial teachings of Lewis to block movement of the hydraulically-driven main arm and Orser to mechanically lock the main arm

to the stop, thereby arriving at the '300 patent's claimed invention. Funk's teachings about skid-steer vehicles with an automatic grade control system for adjusting the height and tilt angle of a mounting structure to maintain the work attachment at a particular elevation and Lewis's teachings about using hydraulic control to block movement of the lift arm would not be impacted by the implementation of Orser's teaching to use a mechanical lock to hold the lift arms in a lowered position. *See supra* §VIII.C. Instead, the teachings, implemented together, would work toward a similar purpose of grading by adjusting a dozer blade height while keeping the lift arms locked in a lowered position.

160. A POSITA would have been motivated to pursue the Funk-Lewis-Orser combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

a. Preventing Unwanted Lift Arm Movement

161. Lewis's teaching to block movement of the skid-steer main arm driven by a hydraulic cylinder would have prompted a POSITA to look to references, such as Orser, that disclose solutions to the problem of "[b]lock[ing] upward movement of the arm." EX1005, 4:34-5:6; EX1009, 2:9-14. Lewis's teaching to use hydraulic controls to "block" movement of the lift arm to optimize the load rating of the lift arm and arm assembly would have prompted the POSITA to look for other means to prevent movements of the lift arms. EX1005, 4:34-5:6.

A POSITA would have appreciated that Orser provides a mechanism "for selectively locking the lift arm to the vehicle body in the lowered position." EX1009, Abstract, *see also* Title ("Lift Arm Lock Down Apparatus and Method"). A POSITA, looking for ways to lock the lift arm in the lowered position as Lewis describes, would have looked to references such as Orser and found a suitable solution.

b. Known Solution to the Problem

162. A POSITA would have understood that mechanically locking a main arm to the chassis of the skid-steer is a known technique for solving the problem that Lewis's teaching introduces—to prevent movement of the main arm. Orser describes that other locking devices were known for use in locking the boom or arm of a vehicle to prevent movement of the same. *See* EX1009, 1:5-2:8. A POSITA would have understood that Orser's mechanical arm lock presents a suitable solution to the problem of unwanted lift arm movement—either in place of or in conjunction with Lewis's suggestion to block hydraulic fluid flow—because Orser's arm lock is specifically designed to work with an arm of a skid-steer. EX1009, 3:32-44, 2:9-14, Figs. 1-2. In particular, Orser describes "a lift arm lock down apparatus…which provides for the locking of the lift arm of a front end loader… to the vehicle body in a lowered position of the lift arm [so that] raising of the lift arm is substantially prevented." EX1009, 2:9-14, *see also id.*, 2:33-39,

2:67-3:9, 3:28-49. Orser's lock is "adapted to secure lift arm 12 to body 16 in a lowered position." EX1009, 3:37-38. A POSITA would have been motivated to use Orser's lock for this purpose as a suitable addition to the Funk-Lewis design to prevent the main arm from moving off the stops and from the lowered position, and further to overcome potential hydraulic fluid leaking and resulting drift of the cylinder and lift arm.

c. Known and Predictable Advantages

163. A POSITA would have appreciated that there are particular advantages to using Orser's arm lock in the Funk-Lewis combination. First, the use of Orser's mechanical lock prevents undesirable movement of the arm due to hydraulic leakage and the resulting drift of the hydraulic lift cylinder and lift arm. As discussed above, a POSITA would have understood that these were limitations that may occur with Lewis' hydraulic locking mechanism. *See supra* §VI.B.4. Using Orser's mechanical arm lock as an additional and separate lift arm locking mechanism with Lewis's hydraulic lock would prevent undesirable movement of the arm due to hydraulic leakage and the resulting drift of the hydraulic lift cylinder and lift arm. Second, locking the arm directly to the stop on the skid loader chassis eliminates potential undesirable movement of the arm due to lost motion within the pivot joints of the lift arm and hydraulic cylinder due to manufacturing clearances and wear of these joints over time. *Supra* §§VI.B.3-4.

A POSITA would have been familiar with the general engineering concept of providing redundancy (e.g., multiple or backup mechanisms) in important, mission-critical systems, and its applicability to a worksite. *Supra* §VI.B.5.

164. Third, a POSITA would have understood that Orser's arm lock provides an additional mechanism to secure the main arm in the lowered position that can be used independently from the hydraulic cylinders. EX1009, 2:19-26 ("It is an advantage of a lift arm lock down apparatus in accordance with this invention, that it may be employed independently of whether the lifting cylinder rod of a lift arm to be locked down must be prevented from retracting or extending, since the lock down apparatus is independent of such a lifting cylinder rod and connects the lift arm itself with the vehicle frame and body"). A POSITA would have understood that it is typical, and at times preferred, to employ multiple mechanisms to provide redundant backups in important systems. *See supra* §VI.B.5. A POSITA would have also understood that a mechanical lock would be useful in cases when the hydraulics are not engaged such as during transport on a truck bed or trailer. During transport, the mechanical lock would prevent potential arm movement when a trailer experiences unexpected shifts or bouncing.

165. Fourth, a POSITA would have understood that Orser's arm lock provides a redundancy to Lewis's blocking of hydraulic fluid to the cylinder that provides an additional mechanism for operators to prevent inadvertent movements

of the main arm, for cost, efficiency and other reasons (for example, to protect operators of the skid-steer during maintenance). EX1009, 1:13-37, 2:1-9; *see also* EX1008, 1:22-27. Redundant main arm locking mechanisms provide a failsafe for use when personnel need to work outside the cab of the skid-steer, for example, in some situations when personnel are working in close proximity to the dozer blade and guiding the skid-steer operator's actions an additional mechanical lock, like Orser's, may be engaged. Orser's arm lock can be engaged from within the operator's cabin without requiring the operator to leave the operator's seat or exit the skid-steer. EX1009, 5:68-6:14. A POSITA would have been motivated by such advantages to use Orser's lock with the Funk-Lewis design to secure the arm in the lowered position.

166. A POSITA would have appreciated that instead of, or in addition to, using Lewis's hydraulic control system to keep the arm on the chassis stop, the mechanical arm lock described by Orser would have been used to the same or similar effect.

C. Claim Element Analysis

1. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

167. The Funk-Lewis-Orser combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole. As discussed, this combination incorporates Orser's disclosure of an arm lock as a supplemental means of securing the main arm of the Funk-Lewis skid-steer in the lowered position against the mechanical stop. EX1009, 2:1-14; *see also id*., 3:32-44, 1:13-37, Figs. 1-2; *supra*, §X.A (summary of Orser), §X.B.1 (motivation-to-combine). As a POSITA would have understood, in the Funk-Lewis-Orser combination, when Orser's arm lock is engaged, the main arm is secured against the stop, "***locking the lift arm*** to the vehicle body in the ***lowered position***." EX1009, Abstract, 1:6-11, 4:19-27; §X.B (combination).

168. Orser provides a teaching of a mechanical "lift arm lock down apparatus" that includes "a lock for selectively securing the lift arm to the vehicle body, when lowered." EX1009, 2:30-36. The lock "lock[s] down a lift arm" by "fixing the lift arm to the vehicle body by means of a lock, when the lift arm is lowered." EX1009, 2:40-46. In the Funk-Lewis-Orser combination, the lift arm is locked to the stops on the chassis of the vehicle. EX1005, 6:59-61 ("***the arm may***

contact the chassis of the work vehicle or ***a stop coupled to the chassis of the work vehicle*** while the arm is in the lowered position"). Implementing Orser's teaching to use a lock to keep the lift arm in the lowered position in the Funk-Lewis system would have resulted in locking the lift arm against the stop when the lift arm is in the lowered position (i.e., when the lift arm is at the lower limit of movement of the arm).

2. Claim 4

[4.pre] The method for controlling a dozer blade as in claim 3 further including:

[4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

169. The Funk-Lewis-Orser combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §VIII.D.3 Element [3.1] and §X.C Element [2.1].

XI. GROUND 1D—OBVIOUSNESS OVER FUNK, LEWIS, STRATIENKO, ORSER

170. Ground 1D is substantively identical to, and incorporates the analysis of Ground 1B, for several claim elements. As discussed at Ground 1C, Orser's supplementary teachings provide an additional/alternative basis for finding Elements [2.1] and [4.1] satisfied and obvious in view of the claims as a whole. Integrating Orser's supplementary teachings with respect to Elements [2.1] and

[4.1] here in Ground 1D does not alter the features of Funk, Lewis, and Stratienko mapped to the other claim elements in Grounds 1B. *Supra* §IX.C.

171. A POSITA would have been motivated to apply Orser's supplemental teachings about a mechanical arm lock for securing the main arm to a skid-steer chassis to the Funk-Lewis-Stratienko combination, which provides for immobilizing the main arm of a skid-steer in a lowered position during automatic grading by using hydraulic controls and an infinite position cylinder lock.[5] *Supra* §IX.B. Although Orser's mechanical arm lock provides an additional mechanical locking mechanism to the Funk-Lewis-Stratienko combination, Orser's mechanical lift arm lock is manually actuated and would have provided a unique and simple mechanism for operators of the skid-steer to use to prevent motion of the lift arm in addition to the power-assisted cylinder lock taught by Stratienko. For example, in some situations, a POSITA would have been motivated to implement Orser's mechanical lock in the Funk-Lewis-Stratienko combination as a failsafe for preventing any movement of the arm. A POSITA would have understood and would have appreciated that the additional mechanical arm lock taught by Orser

[5] I do not mean to imply that additional locking mechanisms (such as the locks described by Stratienko and Orser discussed here and above) would necessarily be required in every situation. However, a POSITA would have considered the addition of redundant locks or locking mechanisms as is general practice at a worksite (*see supra* §VI.B.5), and, in certain situations, a POSITA would have determined that the addition of one or both locking mechanisms would be advantageous for the reasons described herein.

provides an additional and advantageous redundancy to the mechanisms for securing the arm in the Funk-Lewis-Stratienko combination (i.e., blocking hydraulic fluid flow to the cylinder controlling the lift arms and mechanically locking the cylinder rod). *See supra* §VI.B.5. For example, because Orser's mechanical lock operates independently from the hydraulics of the system, the lock provides additional confidence that the arm will not unexpectedly move. Orser's mechanical lock prevents unintentional and undesirable movements resulting not only from hydraulic leakage at the hydraulic valve or from the cylinder, but also prevents undesirable movements of the lift arm resulting from lost motion or mechanical play in the mechanical joints of the lift arm and hydraulic cylinder. *Supra* §§X.A-B and §VI.B.4. Stratienko's teaching of a cylinder rod lock would not protect against lost motion occurring in the pin joints of the lift arm or at the coupling of the lift arm to the chassis or where the cylinder connects to the lift arm – it would only immobilize the lift arm from raising or lowering due to hydraulic actions. As such, Orser's mechanical lock between the arm and the chassis reduces movement due to lost motion between the linkage components of the arm assembly as well as between the arm and chassis, and a POSITA would have been motivated to implement and combine the Funk-Lewis-Stratienko system with the addition of Orser's teaching to use a mechanical lock for this reason. *See supra* §VI.B.4. A POSITA would have understood that redundancy in securing the arm in a lowered

position would provide backup mechanisms for preventing inadvertent movement of the main arm. *Supra* §VI.B.5.

172. A POSITA would have appreciated the benefits of combining both the hydraulic lock and the mechanical lock because the mechanical lock does not suffer from the effects of leakage through the valve. Further examples include situations in which hydraulics would not be applied, such as during transport or while in storage. A mechanical lock would maintain the arms and dozer blade secured in a lowered position while being towed on a trailer. A POSITA would have understood that the use of multiple mechanisms for securing the arm in a lowered position would provide backup options for preventing inadvertent movement of the main arm, and further would offer redundant protections to an operator during maintenance or operation of the skid-steer. EX1009, 1:13-37, 2:1-9, 5:68-6:14.

173. Additionally, a POSITA would have understood that the relatively high costs associated with delays for equipment repair during a grading operation with on-site labor is expensive. *Supra* §VI.B.5. A POSITA would have been interested in exploring redundancies that could be implemented to minimize those costs. For example, when a vehicle is not operational and needs repair, the job may be delayed at high cost. A POSITA would have been motivated to take precautionary actions that prevent the vehicle from being taken out of service when

there is a failure of an important mechanism (like holding the lift arm in the lowered position), especially when the additional and separate mechanisms are simple and economical to install in existing vehicles, as is the case with Orser's mechanical lock. It would have been clear to a POSITA that implementing Orser's manual lock in addition to Stratienko's cylinder lock and Lewis's hydraulic control system provides a low-cost redundancy solution that offers a manual and mechanical option separate from the hydraulic system. As a result, in situations where the other lock mechanism fails, the operator can step in to employ the manual lock to minimize delay and associated costs. Additionally, limiting the motion of the lift arms reduces the wear that occurs in the pins of the lift arms over time with use.

174. A POSITA would have appreciated that in addition to Lewis's hydraulic control system to keep the main arm on the chassis stop and Stratienko's cylinder rod locking mechanism, the manual mechanical arm lock of Orser would have been used to provide additional assurance that the main arm would not inadvertently move during operation (including during grading) or during maintenance.

A. Claim Element Analysis

1. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

175. The Funk-Lewis-Stratienko-Orser combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole for the same reasons discussed above at §X.C.

2. Claim 4

[4.pre] The method for controlling a dozer blade as in claim 3 further including:

[4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

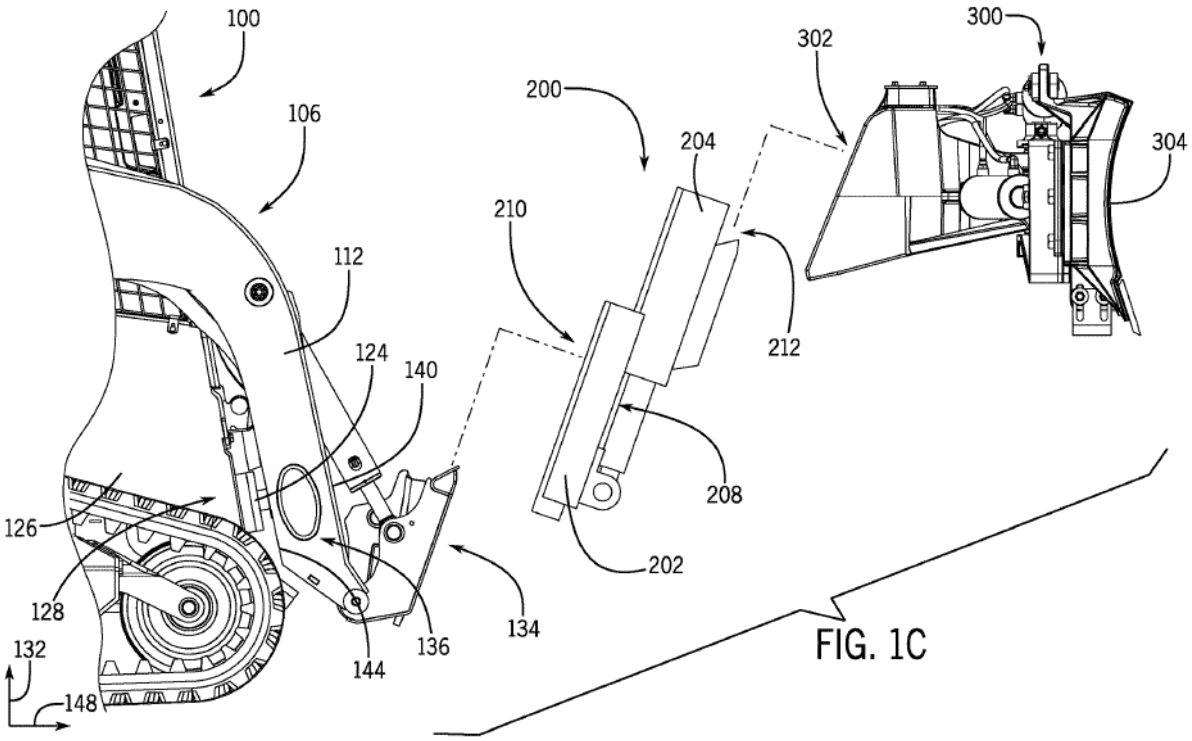
176. The Funk-Lewis-Stratienko-Orser combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §IX.C Element [3.1] and above at §XI.A Element [2.1] (which cross-references §X.C).

XII. GROUND 2A—OBVIOUSNESS OVER ECKROTE, LUMPKINS

A. Eckrote (EX1006)

177. Eckrote explains that "[c]ertain work vehicles (e.g., skid steers) have an arm rotatably coupled to the chassis and configured to support an implement (e.g., dozer blade, grapple, etc.)." EX1006, 1:16-19. Eckrote describes attaching the work implement (dozer blade) to the skid-steer and placing the arms in a

"lowered" position to rest against mechanical stops on the chassis so that "the dozer blade may support heavy loads." *Id.*, 4:2-14. Eckrote further describes a controller for controlling hydraulics associated with movement of the arms and the implement. *Id.*, Fig. 4, 10:60-11:12. According to Eckrote, "the controller may block movement of the arms" to ensure they remain in the lowered position. *Id.*, 10:60-11:12.



EX1006, Fig. 1C (annotated)

Eckrote's controller is part of a control system and includes the "controller 402 having a processor… and a memory device." *Id.*, 9:55-57. "[T]he controller 402 is configured to instruct a valve assembly 408 to control hydraulic fluid flow from a

hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the arms of the arm assembly." *Id.*, 10:12-16. Eckrote's controller is also "configured to instruct the valve assembly 408 to control hydraulic fluid flow from the hydraulic fluid source to the adaptor piston assembly 254 to move the adaptor between the fully extended position and the fully retracted position, which respectively raises and lowers the work vehicle implement coupled to the adaptor." *Id.*, 10:16-22 The controller can instruct the valve assembly "in response to a user input signal" or "based on instructions stored in the memory device." *Id.*, 10:22-28.

B. Lumpkins (EX1007)

178. Lumpkins is about "a dozer blade control system [that] controls the position of a bulldozer blade." EX1007, Abstract. As part of an automatic grading system, Lumpkins uses "a blade position sensor to provide a signal indicative of a position of the blade[] and an electronic controller coupled to the blade and to the at least one lift cylinder" to automatically adjust the blade position "in response to position signals received from the blade position sensor." *Id.*, [0011], [0060].

179. Lumpkins' blade control system is for "keeping the blade of a bulldozer at a selected position as the bulldozer is operated." *Id.*, [0002]. In the "blade pitch control system," Lumpkins describes that the position of the blade can be tilted or rotated "due to (1) extending or retracting the hydraulic lift cylinders or (2) because the chassis of the vehicle pitches." *Id.*, [0036]. When the blade

control system is engaged, "controller 136 operates, generally, by (1) receiving signals indicative of blade position from blade position sensor 134, (2) receiving signals indicative of a preferred or target blade position from device 130 and (3) combining the two signals to keep blade 112 at the preferred or target position." *Id.*, [0041].

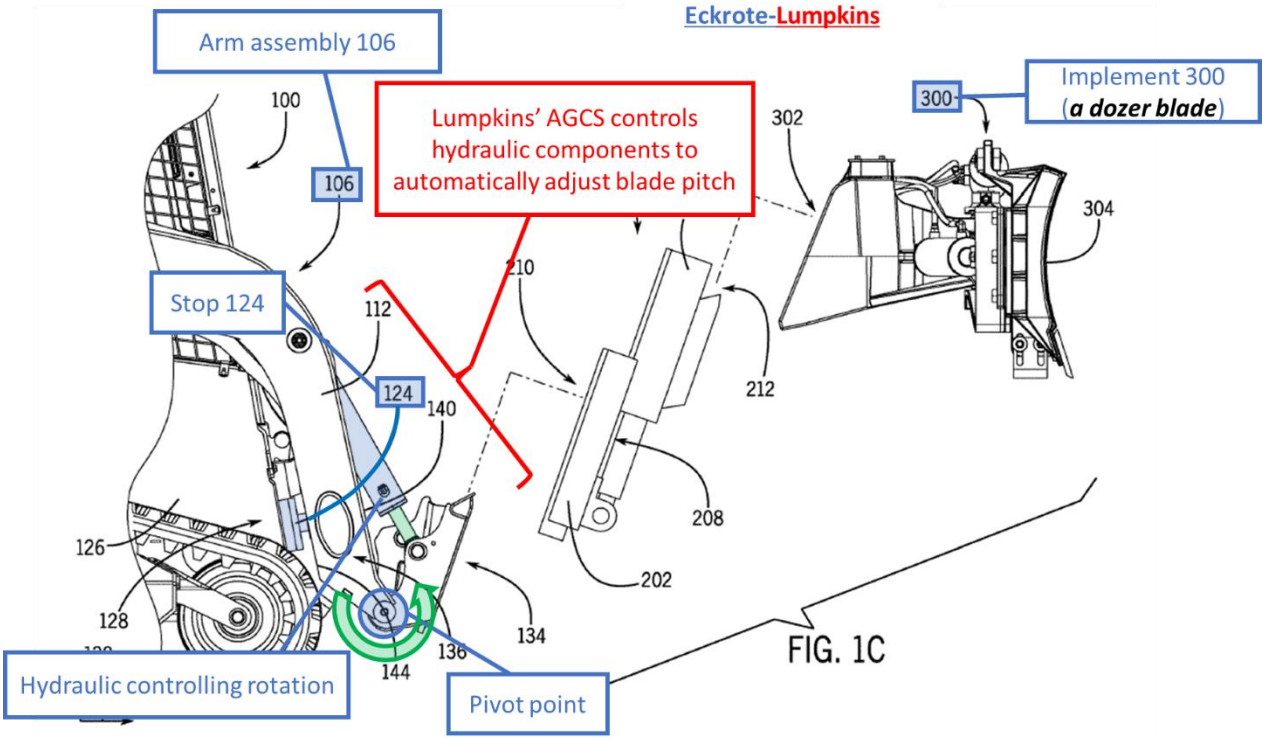
C. The Eckrote-Lumpkins Combination

180. Incorporating Lumpkins' notion of an automatic grade control (sometimes referred to as "AGC") system[6] with Eckrote's disclosure of a skid-steer vehicle carrying a dozer blade is nothing more than pursuing a predictable result—i.e., a skid-steer vehicle with an automatic grading system for positioning the height/pitch of the dozer blade—by combining known prior art elements using known techniques. As explained above, grade control systems were well-established and known to POSITAs by the Critical Date. *See infra* §VI.B.2. Further, it was well known to use skid-steer vehicles with dozer blades for grading operations. *Id.* Indeed, the '300 patent makes clear that neither automatic grade control nor the use of skid-steers with dozer blades for grading operations were new by the Critical Date. EX1001, 1:14-28 ("Several designs for improvement to earth moving equipment have been designed in the past...[however t]he Armas

[6] As noted, Automatic Grade Control is abbreviated in this declaration to AGC. I also abbreviate "Automatic Grade Control System" as AGCS.

prior art maintains the full movement of the main arm of the vehicle to raise and lower the attachment assembly including the dozer blade"), 3:33-39 ("Skid steer vehicles are commonly commercially available…"), 3:44-45 ("Grade control systems, such as laser automation, are commonly commercially available"), 3:61-62 ("With the prior art laser control systems the dozer blade supported the laser control receiver mast… so that the system could use the top of the mast as a datum for referencing the height of the bottom of the dozer blade the[sic] defined the grade being made as the dozer moved over the earth defining the new grade").

181. As shown below, the predictable result of this combination applies Lumpkins' teaching of an automatic grading control system (AGCS) to control various hydraulics shown and described by Eckrote**.**



EX1006, Fig. 1C (annotated and modified)

182. A POSITA would have been well-equipped to combine the known elements of a skid-steer, dozer blade, and automatic grading system for positioning the height and pitch of the blade. As discussed, this feature combination was already known and implemented in the prior art—i.e., skid-steers already were used with grading systems requiring control of blade height and pitch. *Supra* §VI.B.1-2, §VII.A. To combine the elements a POSITA would have simply implemented Lumpkins' teaching regarding automatic grade control systems for dozers onto a skid-steer. To do this, a POSITA would have used a skid-steer's adapter and hydraulic system as Eckrote teaches, with a controller and algorithm as

a means to control the position of the blade for grading, per Lumpkins. EX1006, 4:3-13, 10:12-11:12; EX1007, [0010], [0021], [0038], [0040], [0057], [0060], [0062]-[0065].

183. More fundamentally, the combination of Eckrote and Lumpkins is a combination of mechanical systems which are reliable with highly predictable characteristics and performance, as a POSITA would have understood. Specifically, the integration of Eckrote and Lumpkins would not fundamentally change the operation of each element but would be implemented such that the elements operated together in a complementary fashion to provide enhanced performance. To be clear, the combination of Eckrote and Lumpkins discussed below is a combination based on the teachings of Eckrote and Lumpkins. I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other.

1. Reasons to Combine

184. From a POSITA's perspective in 2018, integrating the supplemental teachings of Lumpkins with Eckrote's skid-steer would have involved nothing more than applying known solutions to known problems in the field of hydraulic systems and controls for earthmoving equipment and vehicles to achieve predictable and reliable earth grading. A POSITA would have been motivated to

pursue this predictable combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

a. AGC was a Well-Known Technology

185. Various grade control systems—including automatic grade control system—had been known for decades and were ubiquitous in the construction and earthmoving industries by 2018. Patent Owner has openly conceded this point in its patent filings. *E.g.*, EX1001, 1:19-54, 3:33-54 ("Grade control systems…are commonly commercially available."); EX1010, 1:23-28 (citing US 4,923,015, filed in 1988), 2:34-45 (citing US 5,375,663, filed in 1993). Lumpkins' "Bulldozer Autograding System" filed in 2004 (14 years before the Critical Date) and Funk's "Automatic Leveling Control System" filed in 2015 (3 years before the Critical Date) both demonstrate the ubiquitous nature of automatic grade control systems. EX1004, Title; EX1007, Title. Simply put, using an AGC system to control the height and pitch of a dozer blade attachment was an exceedingly well-known solution to the equally well-known problem of grading or leveling a ground surface with a work vehicle. Lumpkins employs an AGC system for this purpose, and it would have been axiomatic for a POSITA to do the same in Eckrote. *See supra* §§XII.A-C.

b. AGC Was a Desirable Technology

186. AGC systems had matured to the point of widespread commercial adoption by the time of the ’300 patent. Petitioner, Patent Owner, and many other competitors sold products consisting of or including AGC systems for skid-steers and other work vehicles long before 2018. *See supra* §VI.B.2; *see also* EX1033, 1 (2009 Bobcat press release detailing a skid steer with automatic grade control), EX1042, 6, 10-12. A POSITA would have appreciated that when an operator manually adjusts blade height or pitch during a grading operation, “it can be difficult for even a skilled operator to consistently maintain blade pitch within an optimal range…while simultaneously controlling the various other operational parameters of the work vehicle.” EX1029, [0006]. A POSITA would have appreciated that AGC systems improved earthmoving operations while minimizing worker fatigue or error and would have expected earthmoving vehicles and systems to include or to be compatible with AGC given the improvements of AGC systems over manual systems. *Id.*, [0005]-[0006] Given the state of the marketplace at that time, a POSITA would have been motivated by market forces and design trends to supplement Eckrote’s disclosure of a skid-steer carrying a dozer blade attachment with Lumpkins’ further teaching of an AGC system. Indeed, the POSITA would have appreciated that a skid-steer vehicle lacking AGC functionality would have been difficult to market in a competitive marketplace,

because AGC systems were so ubiquitous that it would have been expected that a skid-steer vehicle for grading would be equipped with AGC technology or be easily retrofit with an add-on AGC system.

c. Similarity of Teachings

187. A POSITA would have been prompted to integrate Lumpkins' disclosure about an AGC system based on Eckrote's teachings and suggestions regarding a "controller" that controls the height of a dozer blade attachment. EX1006, 10:12-28, 10:60-11:12, Fig. 4. Understanding that grading is one of the primary functions of a dozer blade attachment for a skid-steer, the POSITA would have gleaned that Eckrote's "controller" is obviously part of an AGC system because it automatically controls the position of the dozer blade based on instructions in the memory and does not require manual control by an operator. EX1006, 10:12-28. For example, Eckrote's "controller" is "configured to instruct a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the arms of the arm assembly." EX1006, 10:12-16. Additionally, "the controller is configured to instruct the valve assembly 408 to control hydraulic fluid flow from the hydraulic fluid source to the adaptor piston assembly 254 to move the adaptor between the fully extended position and the fully retracted position, which respectively raises and lowers the work vehicle implement coupled to the adaptor."

Id., 10:16-23. Eckrote's suggestion of an AGC system would have prompted the POSITA to seek out supplemental teachings from references like Lumpkins that further expound on that subject.

d. Known and Predictable Advantages

188. A POSITA would have understood that the addition of an AGC system like Lumpkins' would predictably improve a skid-steer vehicle carrying a dozer blade like Eckrote's. For example, the POSITA would have appreciated that each of the following advantages articulated by Lumpkins would also apply to Eckrote:

- "[A] system that at least partially relieves the operator of the burden of manually raising and lowering the blade as the vehicle pitches while traveling over the ground";
- "[A] system that permits the operator to grade faster by automatically controlling blade pitching";
- "[A] system that automatically controls blade pitching faster than an operator can manually control blade pitching."

EX1007, [0010].

189. A POSITA would have appreciated that each of these advantages provides an additional reason to implement Eckrote's system with the teachings of Lumpkins about providing an automatic grading control system. In particular, a

POSITA would have been motivated to implement improvements that simplify or automate the operation of the vehicle in ways that would otherwise require burdensome attention of the operator because doing so would limit the effects of operator fatigue and error in operation and would also result in more efficient operation of the vehicle to provide grading of a worksite.

e. Reasonable Expectation of Success

190. A POSITA would have reasonably expected a successful outcome from the above-discussed combination of teachings from Eckrote and Lumpkins. This conclusion is supported by my prior discussion on the POSITA's background knowledge at §§VI.B.1-3 and my above discussion on the reasons for the combination. As I have explained, the mechanical features involved in the Eckrote-Lumpkins combination—i.e., hydraulically controlled skid-steer lift arms and dozer blade for grading using an automatic grading control system—were all very well-known and widely adopted by 2018. A POSITA bringing these well-known features together in the manner I've proposed would have been reasonably certain that the result of the combination would arrive at the purported invention of the '300 patent (as outlined below in §XII.D). The POSITA would have also understood that these integrated features are fully compatible and would work in combination in the same way (or substantially the same way) that they work individually.

191. Additionally, it would have been well within the POSITA's level of skill to implement such a combination given the advanced state of the art at the time of the '300 patent in 2018. *See Infra* §§VI.A and VI.B.1-2. Implementing the combination would have involved a simple adjustment to the hydraulic controls of Eckrote's lift arm to accommodate Lumpkins' ACGS. EX1006, 4:3-13, 10:12-11:12, Fig. 1C; EX1007, [0011]. For this reason and for the reasons explained above, a POSITA would have been motivated to pursue this combination that would provide predictable results and possessed a reasonable expectation of its success in arriving at the claimed invention of the '300 patent.

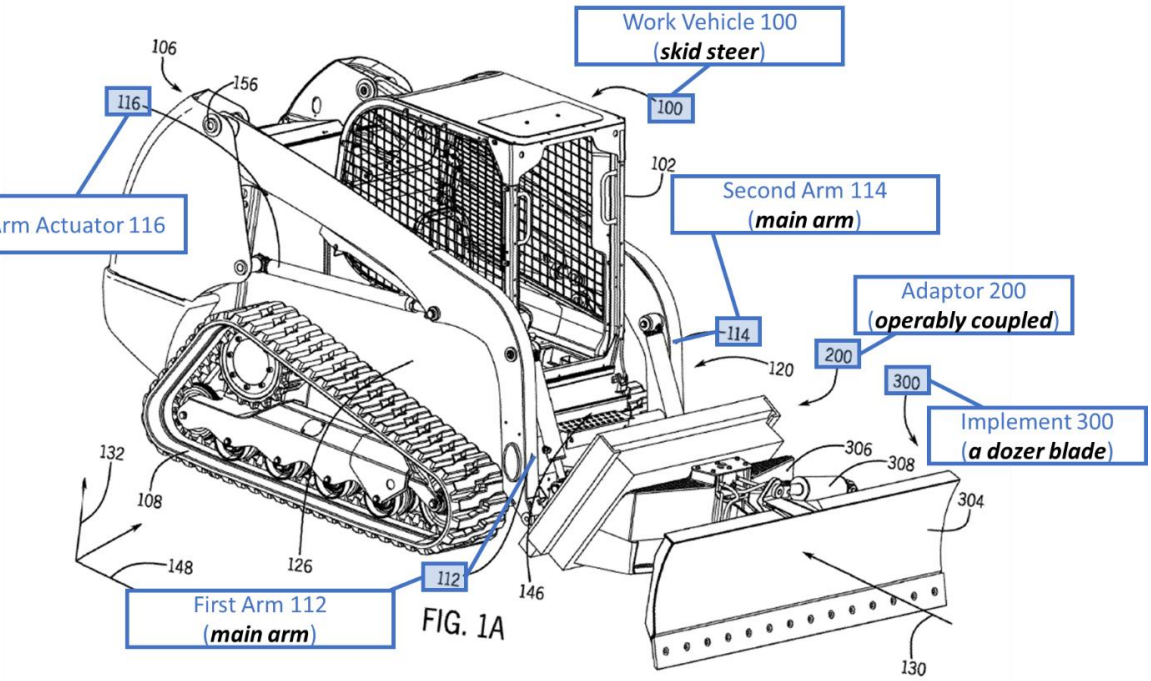
D. Claim Element Analysis

1. Claim 1

Element [1.pre] A method for controlling a dozer blade controlled by an automatic grade control system on a skid steer vehicle comprising:

192. The Eckrote-Lumpkins combination renders obvious Element [1.pre] and Claim 1 as a whole. For example, Eckrote discloses "[a] work ***vehicle*** 100" in the form of "***a skid steer***." EX1006, 2:64-67, Figures 1A-1C; *see also* 3:25-46, 4:3-13. Eckrote further discloses "a work vehicle implement 300 (e.g., ***a dozer blade***) coupled to the work vehicle 100 by an adaptor 200." *Id*., 2:64-65. The adaptor 200 is part of a linkage that further includes "[an] arm assembly [featuring] a first arm 112 and a second arm 114," "a tilt assembly configured to control

rotation of the adaptor 200," and "a tilt assembly 306…configured to drive rotation of the [dozer blade] work implement." *Id.*, 3:27-39, Figure 1A.



EX1006, Fig. 1A (annotated)

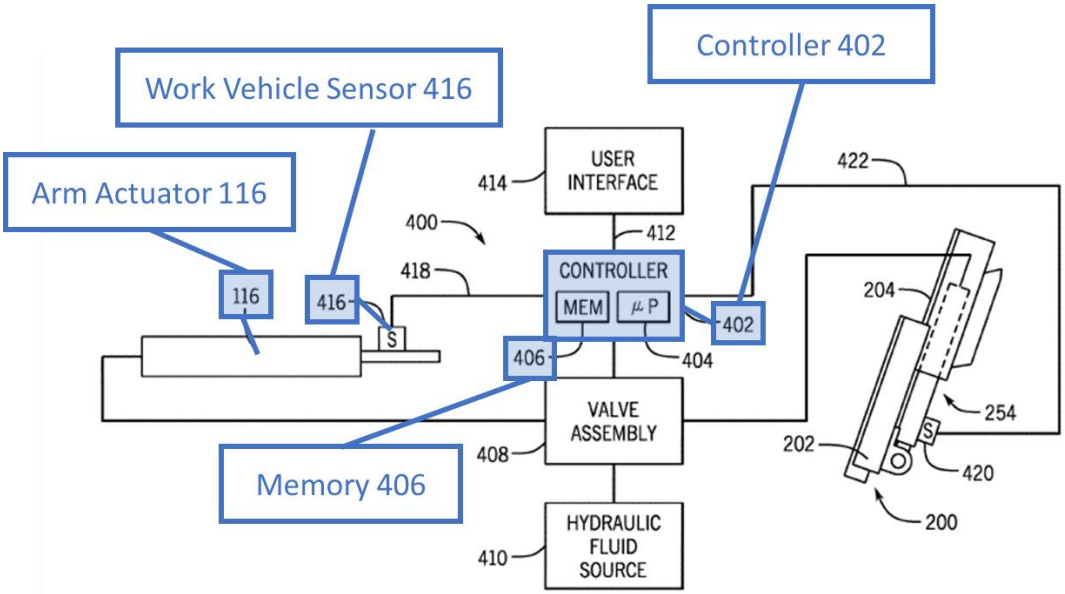


FIG. 4

EX1006, Fig. 4 (annotated)

193. A "***control system***" featuring a controller 402 and a memory device 406 effects "rais[ing] and lower[ing] the arms" and "mov[ing] the adaptor between the fully extended position and the fully retracting position, which respectively raises and lowers the work vehicle [dozer blade] implement[.]" *Id.*, 9:65-10:28, Figure 4. According to Eckrote, the controller may send the instructions to affect these movements "in response to a user input signal" or ***automatically*** "based on instructions stored in the memory device." *Id.*, 10:22-28.

194. Eckrote's disclosure makes clear that Eckrote's system includes a controller that is capable of controlling the elements of the skid-steer, such as raising and lowering the implement, such as a dozer blade. EX1006, 9:65-10:11. Eckrote describes how the controller controls the implement height, including by

"instruct[ing] a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator" and "to the adaptor piston assembly." *Id.*, 10:13-19. Because Eckrote's controller is described as providing such signals either in response to user inputs or based on stored instructions, a POSITA would have understood that the controller can be operated in a manual mode or in an automatic mode without need for a user to input controls. *Id.*, 10:12-28. Thus, Eckrote teaches an ***automatic control system*** and an adjuster specifically for automated grading.

195. A POSITA would have understood Eckrote's teaching of a controller that automatically controls the position of a dozer blade on a skid-steer vehicle to describe or at least suggest an ***automatic grade control (AGC) system***. As described above, Eckrote describes that the controller can control hydraulics of the vehicle "to raise and lower the arms of the arm assembly" or "to raise[] and lower[] the work vehicle implement coupled to the adaptor." EX1006, 10:12-28. Eckrote further teaches that "the arm may support a dozer blade to facilitate earth-moving operations." *Id.*, 1:19-20. A POSITA would have recognized that earth-moving operations, such as those described by Eckrote, are the same as grading operations. Based on Eckrote's disclosure, and for the following reasons, a POSITA would have understood that Eckrote's controller providing automatic control of the arms and work implement provides an automatic grade control system.

196. First, the POSITA would have understood that grading is one of the primary functions of a dozer blade attachment for a skid-steer vehicle. *See supra* §§VI.B.1-2; EX1006, 1:16-20 ("Certain work vehicles (e.g., skid steers) have an arm rotatably coupled to the chassis and configured to support an implement… the arm may support a dozer blade to facilitate earth-moving operations"). Although there are different shapes and types of blades available commercially, dozer blades typically have at least a vertical portion that can be used to push earth or other materials. Eckrote's description of using the dozer blade for "earth-moving operations" is consistent with the common use of dozer blades – to provide grading of a surface. EX1006, 1:8-31. Accordingly, it would have been apparent that Eckrote's ***system*** for controlling the position of a dozer blade is purpose-built or at least suitable for facilitating ***AGC***.

197. Second, the POSITA would have recognized that automatically adjusting the position of a dozer blade is a hallmark feature an ***AGC system***. As described above, using lasers or GPS technology, grading systems operate by comparing a position of the blade to a desired position and controlling the blade height to achieve a set grade plan. *See infra* §VI.B.2, *see also* EX1016, 6; EX1019, 2:18-49, 3:24-52, 4:50-58. Automatic adjustment of the blade to achieve a specific grade eliminates operator error and can increase efficiency at a worksite

because the operator does not need to perform manual adjustments of the blade. *See infra* §VI.B.5 (explaining considerations at a jobsite).

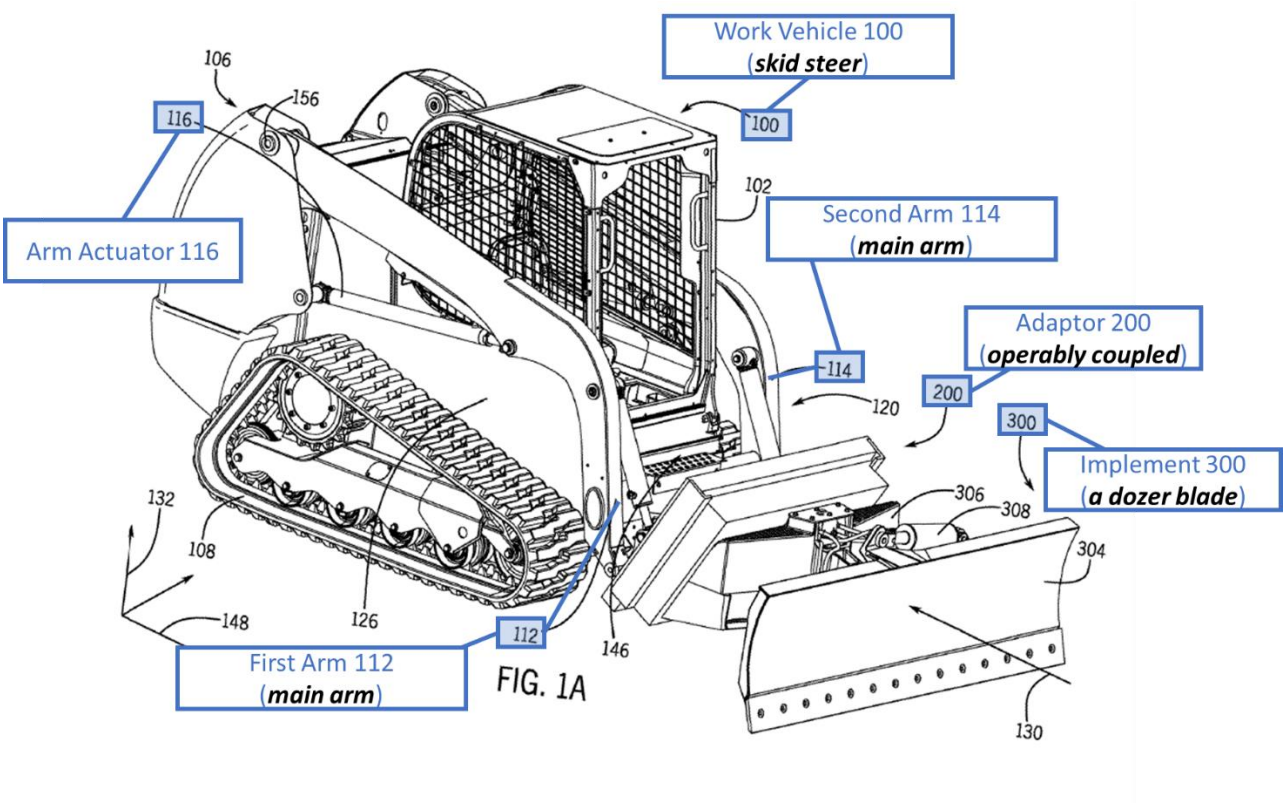
198. Third, the POSITA would have appreciated the prevalence of ***AGC systems*** at the time of Eckrote (and the '300 patent) in 2018. For example, auto-grading and auto-leveling systems were described well before the Critical Date. EX1029, [0006]; EX1032, [0003]-[0007]; *see also generally*, EX1004; EX1007; EX1033. In this context, the POSITA would have reasonably inferred that Eckrote's automatic control system for positioning a dozer blade is an AGC system.

199. Although a POSITA would have understood that Eckrote's controller that automatically moves a blade position without manual inputs is an AGC (as discussed above), alternatively, and as discussed above at §XII.C (combination), this Eckrote-Lumpkins combination incorporates Lumpkins' express teachings regarding "a system that permits the operator to ***grade*** faster by ***automatically controlling blade*** pitching"—namely, an AGC system. EX1007, [0010]; *see also id.*, [0021], [0038], [0040], [0057], [0060], [0062]-[0065].

Element [1.1] providing a skid steer vehicle having a main arm with a front side operably coupled to a dozer blade assembly;

200. The Eckrote-Lumpkins combination renders obvious Element [1.1] and Claim 1 as a whole. For example, and as discussed at Element [1.pre], Eckrote discloses "[a] work ***vehicle*** 100" in the form of "***a skid steer***." EX1006, 2:63-3:15,

Figures 1A-1C; *see also* [0017], [0020]. Eckrote further discloses "a work vehicle implement 300 (e.g., ***a dozer blade***) ***coupled*** to the work vehicle 100 by an adaptor 200." *Id.*, 2:64-65 The adaptor 200 is part of a linkage that further includes "[an] arm assembly [featuring] a first [***main***] ***arm*** 112 and a second [***main***] ***arm*** 114," "a tilt assembly configured to control rotation of the adaptor 200," and "a tilt assembly 306…configured to drive rotation of the [dozer blade] work implement." *Id.*, 3:26-40, Figure 1A.



EX1006, Fig. 1A (annotated)

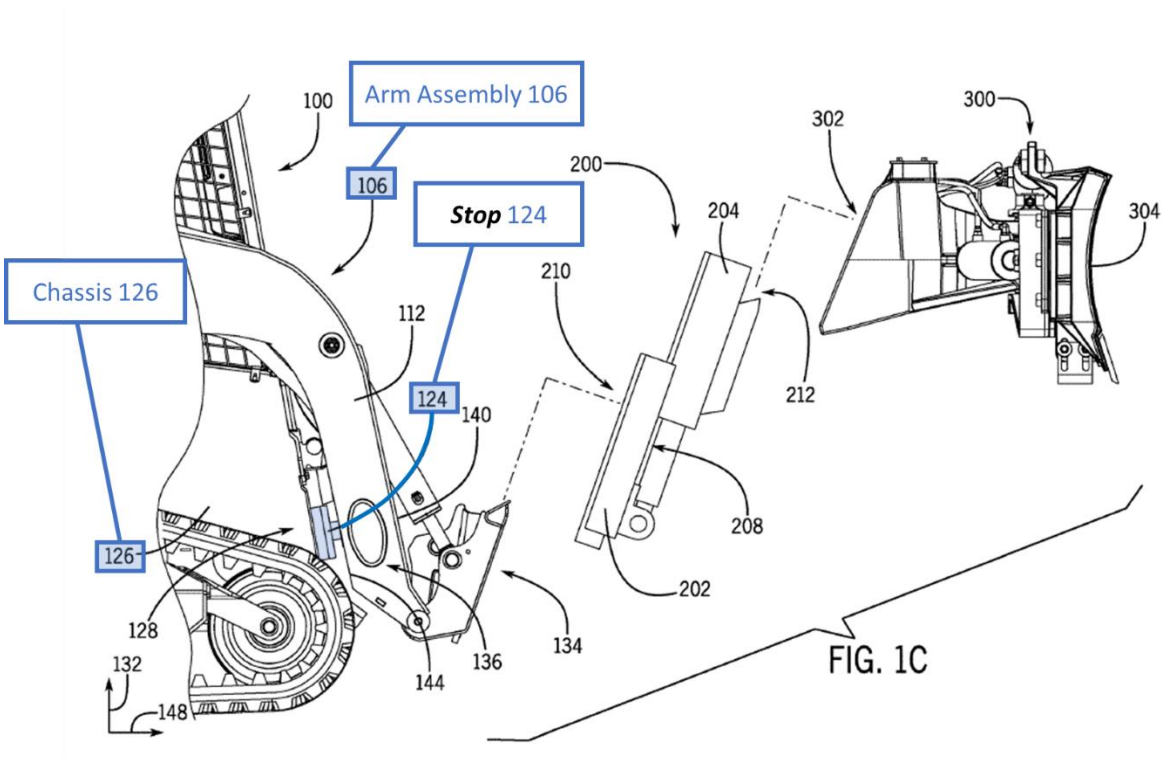
201. As shown above in Eckrote's Fig. 1A, Eckrote's ***dozer blade assembly*** is ***operably coupled to a front side of the arm*** assembly through, e.g., the adaptor and tilt assemblies. *Id.* This positioning of the dozer blade on the front side of the

arm is unsurprising, as coupling the blade or working implement to the front side of the main arm was a well-known and common configuration for skid-steers by the Critical Date. *See e.g.*, EX1010, Fig. 1; EX1014, [0013], Fig. 1

Element [1.2] providing a stop connected to the skid steer vehicle upon which a point of the main arm rests thereby defining a lower limit of movement of the main arm;

Element [1.3] positioning the point of the main arm against the stop;

202. The Eckrote-Lumpkins combination renders obvious Elements [1.2] and [1.3] and Claim 1 as a whole. For example, Eckrote discloses that "[t]he [skid steer] work ***vehicle*** may include mechanical ***stops*** [124] to support ***the*** [***main***] ***arms*** of the arm assembly 106 while the arms are in the ***lowered*** position." EX1006, 3:53-4:13; *see also* 4:14-47, 5:12-37, 10:60-11:12. These mechanical ***stops*** are ***connected to the skid-steer vehicle*** chassis by an "attach[ment]…on a lower front portion of the chassis 126." *Id*. Eckrote goes on to disclose that, "[t]o support the arms of the arm assembly 106, the mechanical stops contact the arms while the arms are in the lowered position." *Id*., 3:60-62. In other words, and as illustrated below, ***points of the main arms are positioned against the stops***, such that ***the main arms rest upon the stops***. And because the main arms rest against the stops "while the arms are in the lowered position," EX1006, 3:58-67, the stops ***define a lower limit of movement of the main arms***.



EX1006, Fig. 1C (annotated)

203. Further, as described above, a POSITA would have recognized that the use of stops on a skid-steer was conventional by the Critical Date, and further that resting the lift arms against the chassis and/or stops on the chassis was well-known by the Critical Date when operating skid-steers for grading. *See* EX1015, 1:32-36 ("In some prior art skid steer loaders, a separate lift arm stop is mounted to each side of the main frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"); *see also* EX1014, [0003] ("some skid steer machines have a separate lift arm stop mounted to each side of the frame so as to engage a respective one of the lift arms when the lift arms are lowered to their lowered positions"), EX1013, [0004] ("It is common for a blade of

a grading system to sit level with the tracks of a vehicle on a ground surface when the vertically movable arms of the vehicle are moved to a lowermost position against stops."); EX1011, 3:27-35.

Element [1.4] preventing the ability of the main arm from providing any lifting force by restricting the ability of a hydraulic that lifts the main arm;

204. The Eckrote-Lumpkins combination renders obvious Element [1.4] and Claim 1 as a whole. For example, Eckrote discloses that "the controller 402 does not enable the arms of the arm assembly to move when the adaptor is coupled to the work vehicle." EX1006, 10:60-63; *see also* 2:10-33, 10:12-11:12. Specifically, "if the adaptor is attached and the arms of the arm assembly are in the fully lowered position, then the controller may block movement of the arms." *Id*., 10:62-65. By "block[ing]" their movement from "the fully lowered position," Eckrote's controller ***prevents the ability of the main arm from providing any lifting force***. *Id*., 10:60-11:12. An arm that is "blocked" from movement, as Eckrote describes, cannot move in an upward or downward direction. As a POSITA would have understood, if the arms cannot move upward from the lowered position, they cannot provide a lifting force because a "lifting force" requires the arms to be moved in the upward direction.

205. Additionally, it would have been apparent or obvious to the POSITA that Eckrote's controller blocks arm movement in this way ***by restricting the ability of a hydraulic that lifts the main arm***. *See supra* §VI.B.3. Hydraulics are

operated to move the main arm, and blocking arm movement using the hydraulics would require that the hydraulics be restricted (e.g., at the valve). *Id.* Eckrote's description makes this connection between the hydraulics and the movement of the lift arm clear. For example, the POSITA would have reached this conclusion from Eckrote's disclosure that:

> [T]he controller 402 is configured to instruct a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the [main] arms of the arm assembly.

EX1006, 10:12-16, Figure 4. In short, the controller 402 controls movement of the main arms by instructing a valve assembly 408 to regulate the flow of hydraulic fluid to the actuator 116 that raises and lowers the main arms. *Id*., 10:12-28. Even aside from Eckrote's clear description, a POSITA would have understood that this is how skid-steer arms are conventionally controlled. *See infra* §VI.B.3. Accordingly, the POSITA would have understood that Eckrote's controller 402 blocks upward movement of the main arms from the fully lowered position by using the valve assembly 408 to prevent hydraulic actuation (***restrict the ability or lock in place***) of the arm actuator 116 (***a hydraulic***) ***that lifts the main arms***. *Id*., 2:63-3:15, 2:10-33, 10:60-11:12. As described above, to control an arm of the skid-steer, the controller controls the flow to the hydraulic cylinder. *See infra* §VI.B.3; *see also* EX1006, 10:12-28. By moving the spool within the valve, the hydraulic fluid can be blocked

from flowing to or from the hydraulic cylinder to prevent any actuation of the cylinder.

206. Eckrote provides no other means of blocking the main arms from moving other than by the controller providing instructions to the control the hydraulic system. *See* EX1006, 10:12-15 ("the controller 402 is configured to instruct a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116"), 10:64-65 ("the controller may block the movement of the arms"), 11:5-7 ("The controller may be configured to block the adaptor from raising the work vehicle implement."). Eckrote describes that the skid-steer vehicle includes "a hydraulic system" which includes "a pump, valves, a reservoir, etc." which operate with other systems of the vehicle to "facilitate operation of the work vehicle." *Id.*, 2:63-3:15; *see also* 2:10-33. When Eckrote describes that "if the adaptor is attached and the arms of the arm assembly are in the fully lowered position, then the controller may block movement of the arms," a POSITA would have understood that the controller does so through the control of the hydraulic system. Accordingly, it would have been axiomatic to use the hydraulic system Eckrote expressly describes to implement this movement blocking functionality.

Element [1.5] operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface.

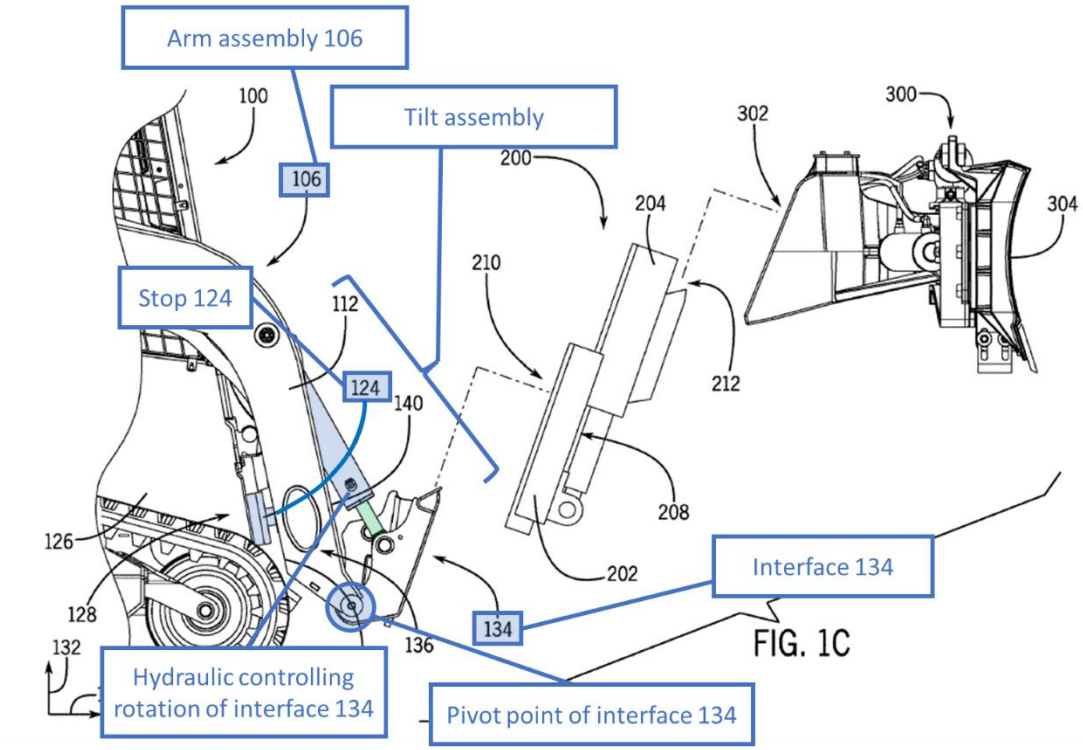
207. The Eckrote-Lumpkins combination renders obvious Element [1.5] and Claim 1 as a whole. To start, and as discussed at [1.pre], Eckrote alone or in view of Lumpkins provides an ***automatic grade control (AGC) system***. *See infra* §§XII.C and XII.D.1 Element [1.pre]. This combination also provides the additional claim feature of ***operably connecting the AGC system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface***.

208. As explained above, AGC systems that control the position of the blade for earth-moving and grading operations were well-known by the Critical Date. *See infra* §§VI.B.2 and XII.C.1.a. A POSITA would have known that AGC systems operate by automatically controlling a blade position and would have further known that blade position is controlled through the use of the vehicle hydraulics. *See e.g.*, EX1032, [0009] (describing that in an automatic precision grading control system "at least one GNSS sensor and at least one inertial sensor are mounted on the dozer body, and at least one stroke sensor is operatively coupled to at least one hydraulic cylinder controlling the dozer blade"); *see also* EX1029, [0008] ("a command [to rotate the blade to an optimized pitch angle] is transmitted from the one or more controllers to a blade actuation system"), [0026]

("blade actuation system 40 includes two hydraulic lift cylinders 42… and two hydraulic pitch cylinders 44"). The analysis below presents two alternative (and non-mutually exclusive) theories to address this feature.

Theory #1

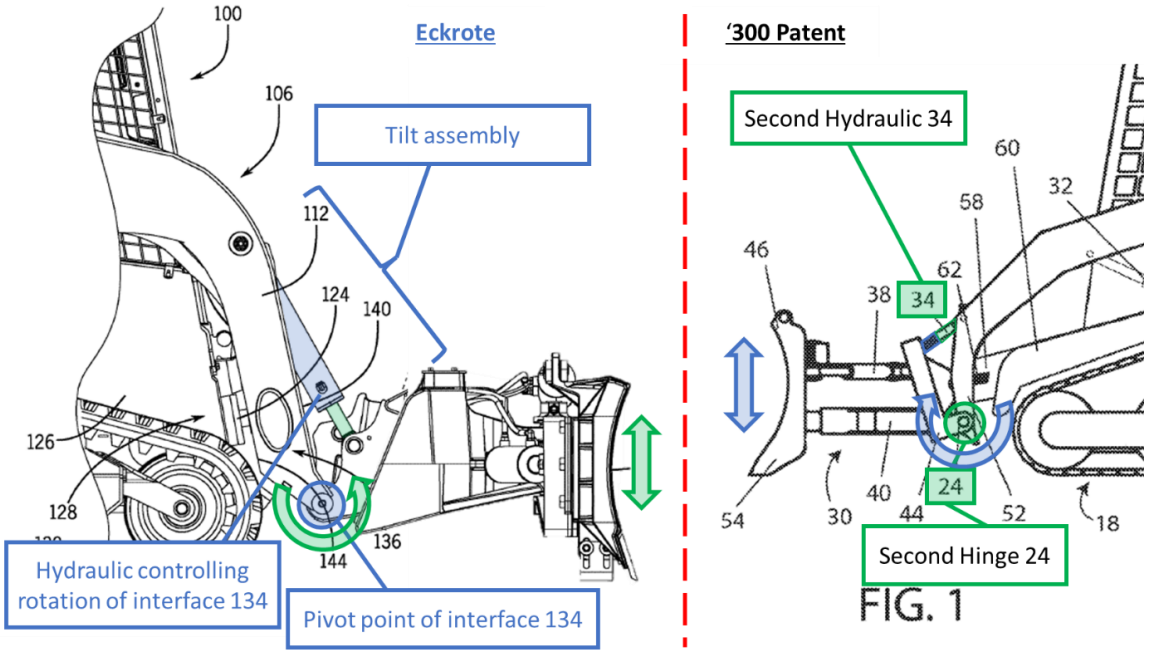
209. Theory #1 relies on Eckrote's disclosure that "the arm assembly 106 includes a tilt assembly configured to control rotation of the adaptor 200." EX1006, 3:35-36, Figures 1A-1C. According to Eckrote, the components of the arm assembly 106—which includes the tilt assembly—are driven by "hydraulic cylinder(s)." *Id*., 3:25-46. As shown below in Figure 1C, this tilt assembly for rotating the adaptor includes a hydraulic cylinder attached to the connector interface 134 that connects the main arms 112, 114 and the adaptor 200. *Id*., 3:25-46, 4:48-5:11. Figure 1C also shows that the tilt assembly further includes a pivot joint as the connection between the arms and the connector interface. *Id*.



EX1006, Fig. 1C (annotated)

210. As would have been clear to a POSITA, extension and retraction of the tilt assembly cylinder causes the interface connector 134, and thus the adaptor 200 supporting the dozer blade, to rotate about a ***pitch axis*** of the pivot point relative to the main arms 112, 114. Here, a POSITA would have recognized that the pitch axis formed by the center of rotation of the pin which is the pivot point of interface 134, as illustrated in the above Figure. EX1006, Fig. 1C. As a result, the linear position of the hydraulic cylinder dictates the angular position of the interface connector 134, which raises/lowers the distal end of the adaptor 200 where the dozer blade is attached.

211. Eckrote describes that "the arm assembly 106 includes a tilt assembly configured to control rotation of the adaptor 200." EX1006, 3:35-36. Eckrote also describes that "[t]he tilt assembly 306 includes a hydraulic cylinder 308 configured to drive rotation of the work implement." *Id.*, 3:38-40. It would have been obvious to a POSITA that Eckrote's tilt assembly operates by using the hydraulic cylinders of the skid-steer to control the position of the blade around a pitch axis. *Id.*, 3:25-46. Accordingly, the ***hydraulic*** cylinder ***controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface***. The '300 patent describes and illustrates a similar arrangement for using pitch axis rotation to affect blade height. *E.g.*, EX1001, 4:20-38, 6:25-36, 6:39-42, 6:55-67, 8:12-26, Figs. 3-4, Figure 2.



Left: EX1006, Fig. 1C (annotated)

Right: EX1001, Fig. 2 (annotated)

212. Additionally, it would have been apparent or obvious to a POSITA exercising common sense and using routine engineering skills and tools that the ***hydraulic*** cylinder of Eckrote's above-discussed tilt assembly is ***operably connected to the AGC system*** (as taught by Eckrote alone or in view of Lumpkins, per Element [1.pre]). First, Eckrote indicates that the components of the "arm assembly"—which includes the "tilt assembly"—can be controlled by "an input device (e.g., one or more hand controllers, levers, etc.)." EX1006, 3:25-46. In addition to "hand controllers," Eckrote also describes an automatic control (AGC) system for controlling hydraulically driven assemblies. EX1006, :65-10:59, 3:16-46; *see also supra*, Element [1.pre]. Given that the ***control (AGC) system*** is one of

two options Eckrote discloses for controlling the position of the dozer blade using the ***hydraulic*** cylinder of the tilt assembly, the notion of ***operably connecting*** these components would have been exceptionally apparent or exceedingly obvious to the POSITA. Connecting the control system to the hydraulic cylinder to allow the AGC to control the movement and tilt of the blade would have been obvious – without such a connection, the AGC could not accomplish its purpose of automatically controlling the blade for grading. Second, operably connecting the ***control (AGC) system*** with tilt assembly's ***hydraulic*** cylinder also would have been obvious in view of Eckrote's express disclosure to control (and operably connect) the control system with other hydraulically-driven components in the same linkage, e.g., the main arms and adaptor. *See also supra*, §§XII.D.1 Element [1.4] and VI.B.3.

Theory #2

213. Theory #2 relies on Eckrote's disclosure discussed above at Element [1.4] that the ***hydraulic*** actuator for the main arms 112, 114 is controlled by, and thus ***operably connected to***, ***the control (AGC) system*** (as taught by Eckrote alone or in view of Lumpkins, per Element [1.pre]). EX1006, 3:31-34 ("The arm assembly 106 includes at least one arm actuator 116 configured to extend and retract to control the position of the first and second arms 112, 114"), 10:12-16 ("the controller 402 is configured to instruct a valve assembly 408 to control

hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the arms of the arm assembly"); *supra*, Element [1.4].

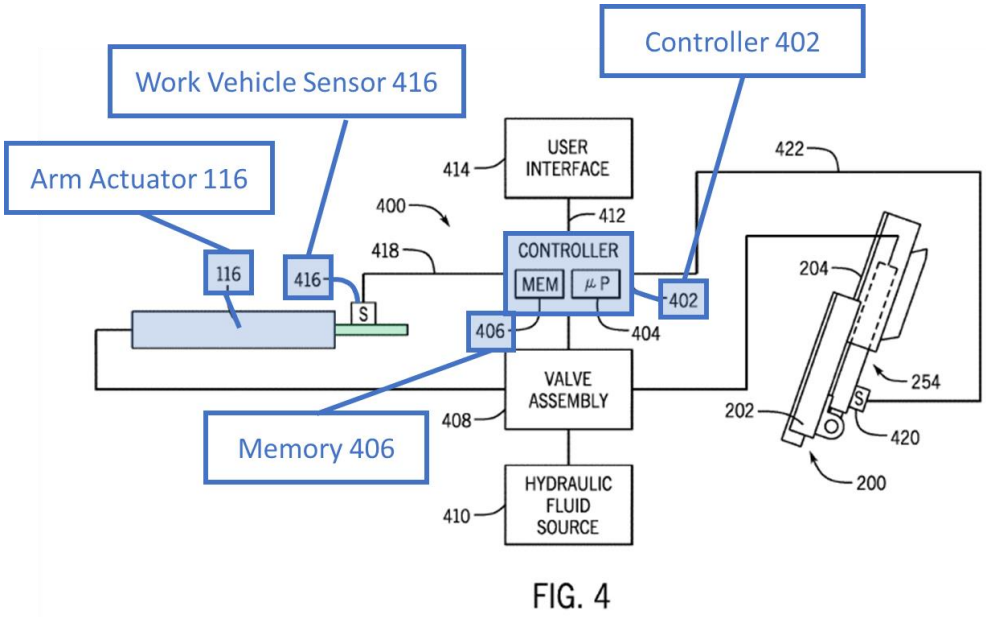


FIG. 4

EX1006, Fig. 4 (annotated)

214. As illustrated below, the main arms 112, 114 are part of a linkage that further includes the adaptor 200, two tilt assemblies, and the dozer blade implement. EX1006, 3:25-3:52. As Eckrote explains, the main arms 112, 114 "are movable between a lowered position 120 and a raised position" via rotational movement about the ***pitch axis*** of "a respective pivot joint 156" that is controlled by the "at least one arm [***hydraulic***] actuator 116." *Id.*, 3:25-3:52; *see also* 3:53-4:13, 10:12-28, 10:60-11:12, Figures 1A-1C, Figure 4. Because the ***dozer blade*** and main arms are part of the same mechanical linkage, the ***pitch axis*** movement

of the main arms is transmitted to the ***dozer blade*** and ***affects the height of the dozer blade relative to a ground surface***.

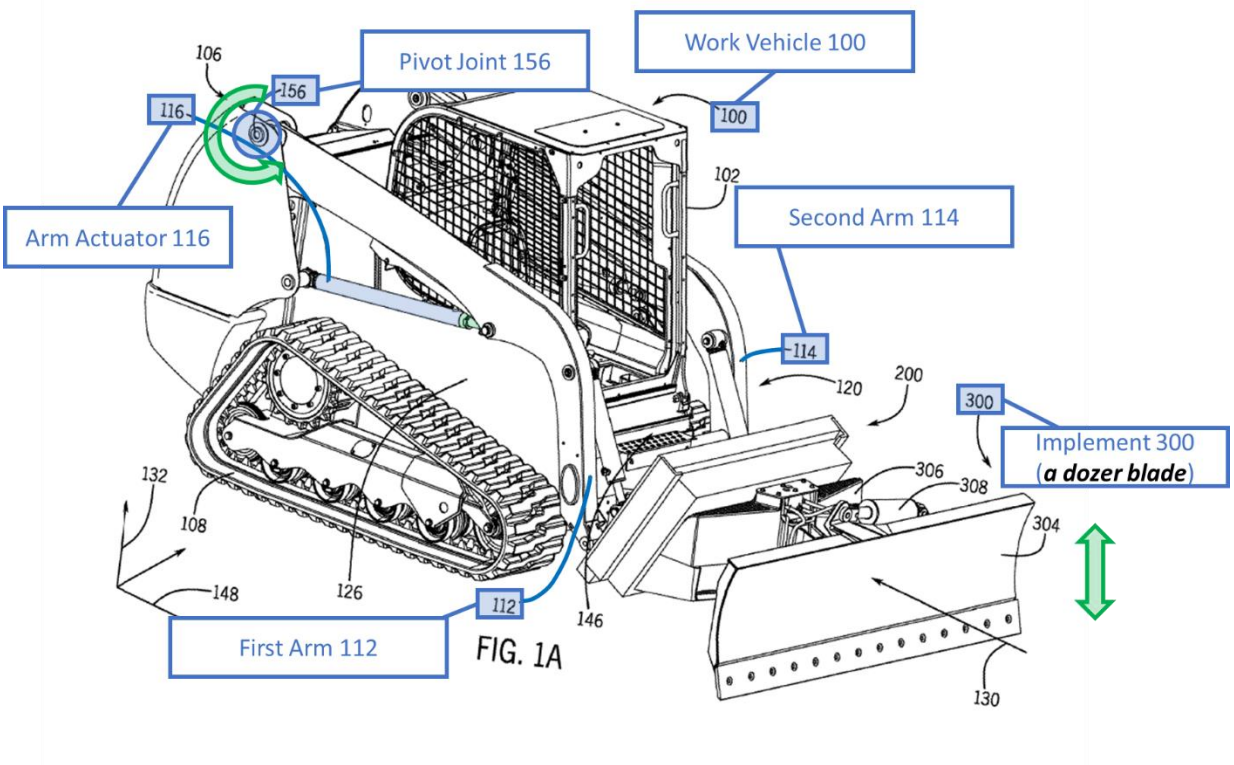


FIG. 1A

EX1006, Fig. 1A (annotated)

215. Notably, Theory #2 points to the same "hydraulic" for both of the Elements [1.4] and [1.5]—the hydraulic actuator that drives the main arms. The breadth of the Challenged Claims permits this mapping. For one, each of Elements [1.4] and [1.5] generically references ***a hydraulic***. The indefinite article "a" in each instance makes clear that no particular hydraulic is required, as long as the surrounding claim limitations are met. Additionally, I understand that the fact that Element [1.4] requires ***restricting the ability of a hydraulic*** does not impact or change the scope of Element [1.5], which separately requires ***operably connecting***

the automatic grade control system to a hydraulic. *See supra* §V.C. Accordingly, and because the surrounding claim limitations do not require otherwise, Element [1.4]'s hydraulic and Element [1.5]'s hydraulic can be the same or different.

2. Claim 2

Element [2.pre] The method for controlling a dozer blade as in claim 1 further including:

Element [2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

216. The Eckrote-Lumpkins combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole, including for similar reasons discussed above at Element [1.2], [1.3], and [1.4]. As discussed, Eckrote's controller blocks movement of (***locks***) ***the main arms*** at ***a lower limit of movement*** that is ***against the stops*** by preventing actuation of the hydraulic actuator that lifts the main arms. *Supra*, Elements [1.2], [1.3], [1.4].

217. As described above, Eckrote's controller blocks movement of the arms when the arms are in the lowered position. EX1006, 10:60-11:12. Eckrote describes that "the controller 402 is configured to instruct a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the [main] arms of the arm assembly." *Id.*, 10:12-16. Because the arm actuator is blocked from moving, the arm is held stationary against the stop and is effectively locked in place. *Id.*, 10:12-28.

3. Claim 3

Element [3.pre] The method for controlling a dozer blade as in claim 1 further including:

Element [3.1] operating a valve to hydraulically isolate the hydraulic lift that lifts the main arm to further prevent any movement of the main arm.

218. The Eckrote-Lumpkins combination renders obvious Elements [3.pre] and [3.1] and Claim 3 as a whole, including for similar reasons discussed above at Element [1.2], [1.3], and [1.4]. As discussed, Eckrote's controller blocks arm movement away from the stops by ***operating a valve*** assembly. *Supra*, §XII.D.1 Elements [1.2], [1.3], [1.4]. Eckrote describes that "the controller 402 is configured to ***instruct a valve assembly 408*** to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the [main] arms of the arm assembly." *Id.*, 10:12-16. A POSITA would have understood that Eckrote's direction to instruct a valve assembly to control hydraulic fluid flow is a typical ***operation*** of a valve. *See supra* §VI.B.3. In particular, as described above, hydraulic control systems utilize valves to control the flow of hydraulic fluid to and from a hydraulic cylinder—i.e., the valves are used in the control of the movement of the cylinder. *See id*. In most cases, operation of the valve is accomplished by transmitting a control signal to move a spool within the valve, the position of the spool determining the direction of flow of hydraulic fluid through the valve. *Id.*

219. From a POSITA's perspective, it would have been apparent or obvious to operate the valve assembly to achieve this result by ***hydraulically isolating***, and therefore preventing actuation of, the ***hydraulic*** actuator that ***lifts the main arms***. *See supra* §VI.B.3. By controlling the valve to block the flow of hydraulic fluid to or from the hydraulic lift cylinder, no fluid can move into or out of the hydraulic lift cylinder. The hydraulic lift cylinder is thus "isolated" in that there is no fluid that is coming in or moving out of the lift cylinder, and no motion of the cylinder can occur. When the cylinder is unable to move (because there is no flow of hydraulic fluid in or out of the cylinder), the cylinder cannot provide a moving force to the equipment that it typically moves – in this case the lift arm.

4. Claim 4

Element [4.pre] The method for controlling a dozer blade as in claim 3 further including:

Element [4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

220. The Eckrote-Lumpkins combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §XII.D Elements [3.1] and [2.1].

XIII. GROUND 2B—OBVIOUSNESS OVER ECKROTE, LUMPKINS, STRATIENKO

221. Ground 2B is substantively identical to, and incorporates the analysis of Ground 2A, for several claim elements. Stratienko's supplementary teachings

provide an additional/alternative basis for finding Element [1.4] and Claims 2-4 satisfied and obvious in view of the claims as a whole. Integrating Stratienko's supplementary teachings with respect to Elements [1.4], [2.1], [3.1], and [4.1] here in Ground 2B does not disturb the aspects of Eckrote and Lumpkins mapped to the other claim elements in Ground 2A.

A. The Eckrote-Lumpkins-Stratienko Combination

222. The Eckrote-Lumpkins-Stratienko combination represents the predictable result of applying Stratienko's supplemental teachings about an infinite position mechanical locking device for preventing motion of a hydraulic actuator in the context of the Eckrote-Lumpkins system of a skid-steer vehicle with an automatic grading system for positioning the height/pitch of the dozer blade. In this combination, Stratienko's teaching to use an infinite position mechanical lock to prevent movement of the hydraulic cylinder rod is combined with the teachings of Eckrote-Lumpkins (described above). I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other. In effect, Stratienko's device provides a teaching of a mechanism for locking the hydraulic cylinder that controls movement of the skid-steer's main arm in the Eckrote-Lumpkins combination. From a POSITA's perspective in 2018, applying Stratienko's supplemental teachings in this way would have involved nothing more

than applying a known solution to the known problem of preventing "undesirable movements of the rod," (EX1008, 1:22-27)—a problem acknowledged in Eckrote's teaching to "block movement of the arms" to ensure they remain in the lowered position. EX1006, 10:60-11:12. The fundamental aspects of Eckrote's disclosure would remain intact, bolstered by the well-known and beneficial teachings of Lumpkins to utilize an automatic grading system and Stratienko to prevent movement of a hydraulic cylinder, thereby arriving at the '300 patent's claimed invention.

1. Reasons to Combine

223. A POSITA would have been motivated to pursue the Eckrote-Lumpkins-Stratienko combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons. Further, a POSITA would have had at least a reasonable expectation of success since this combination integrates highly predicable mechanical systems.

a. Preventing Undesirable Movements

224. Eckrote's teaching to block movement of the arm with a controller that controls hydraulic fluid flow to the arm actuator would have prompted a POSITA to look to references, such as Stratienko, that disclose solutions to the problem of preventing "undesirable movements" of a hydraulic cylinder rod used to move a lift arm. EX1008, 1:22-27; EX1006, 10:60-11:12, 10:12-28; *Supra*

§§VI.B.3-4. Eckrote's teaching to use hydraulic controls to "block" movement of the lift arm in the lowered position would have prompted the POSITA to look for other means to prevent movement of the lift arms. EX1006, 10:60-11:12. A POSITA would have appreciated that Stratienko provides just such a mechanism "for locking a rod in a conventional hydraulic actuator." EX1008, Abstract, *see also* Title ("Locking device for hydraulic actuator").

b. Known Solutions to the Problem

225. A POSITA would have understood that locking a cylinder rod with a mechanical lock is a known technique for solving the problem that Eckrote's teaching introduces—to prevent movement of the main lift arm. *see also* EX1008, 1:21-34 ("Conventional locking devices are generally either the mechanical type or the hydraulic type"). Stratienko describes multiple reasons "to lock the driven rod in a hydraulic actuator" including "to avoid small, but undesirable[,] movements of the rod due to leaking of hydraulic fluid past the seals within the actuator or because of compressibility of the hydraulic fluid." EX1008, 1:22-27. Stratienko contrasts the infinite position lock with "[c]onventional locking devices." *Id.*, 1:27-28. A POSITA would have further understood that methods for locking a hydraulic cylinder in a position fall into the categories of either mechanical or hydraulic locks, just as Stratienko teaches. *Id.*, 1:21-34 ("Conventional locking devices are generally either the mechanical type or the hydraulic type"). Stratienko

describes that a "third type of mechanical locking device is the infinite position type which locks at any point of stroke" and "has the broadest application possibilities." *Id.*, 1:62-64.

226. Specifically, Stratienko's solution from 1977, prevents a well-known issue of hydraulic drift. *Supra,* §VI.B.4. For example, a failing or damaged component could cause errant flow of hydraulic fluid that could result in the hydraulics drifting from their intended position. EX1023, 1:29-34; EX1031, 1:53-60. As described above, the cylinder drift can occur due to worn seals, poor tolerances during manufacturing, or from damage. Stratienko's lock circumvents concerns of cylinder drift by preventing the hydraulic shaft from moving *regardless* of cylinder pressure. Because of this, a POSITA would have known that the fluid leakage within a hydraulic system can lead to creep and unintended movement of the hydraulic cylinder and therefore the lift arm.

c. Easily Implemented Solution to the Problem

227. Stratienko describes that the "ring-contracting member is preferably designed to withstand the rod force so that it can lock the rod against movement in either direction." EX1008, 6:59-62. A POSITA would have appreciated from Stratienko's description that the cylinder lock (and its ring-contracting member) would be used to block movement of the cylinder rod to keep the lift arm in the lowered position. Stratienko describes that the "ring-contracting member is

preferably designed to withstand the rod force so that it can lock the rod against movement in either direction." EX1008, 6:59-62. A POSITA would have appreciated from Stratienko's description that the cylinder lock (and its ring-contracting member) would be used to block movement of the cylinder rod to keep the lift arm in the lowered position. A POSITA would have also understood that Stratienko's mechanical cylinder lock presents a suitable solution to the problem—either in place of or in conjunction with Eckrote's suggestion to control the hydraulic fluid flow to the arm actuator—because Stratienko's cylinder lock is specifically designed to work with high-power hydraulic cylinders, such as those on a skid-steer. EX1008, 2:67-3:9, 3:28-49, 2:33-39; EX1006, 2:63-3:15, 3:25-46, 4:48-5:11, 10:12-28, 10:45-11:12, Fig. 4. A POSITA would have understood from Stratienko's description that the cylinder lock is compatible with hydraulic cylinders that would be used in a skid-steer to raise and lower the lift arm. In fact, in the "Field of Invention" section of Stratienko's patent, it is specifically stated that "[t]he present invention relates to hydraulic actuators of the type used to exert large forces." EX1008, 1:13-14.

228. Additionally, Stratienko's lock can be engaged at any point of the stroke, including when the cylinder is contracted and the lift arm (and the dozer blade) is in the lowered position – even in the lowest position of the lift arm. Stratienko describes that the "ring-contracting member is preferably designed to

withstand the rod force so that it can lock the rod against movement in either direction." EX1008, 6:59-62. A POSITA would have appreciated from Stratienko's description that the cylinder lock (and its ring-contracting member) would be used to block movement of the cylinder rod to keep the lift arm in the lowered position. A POSITA would have been motivated to use Stratienko's lock for this purpose as a suitable addition to the Eckrote-Lumpkins design to prevent the main lift arm from moving.

d. Known and Predictable Advantages

229. Even setting aside Eckrote's express instruction, a POSITA would have appreciated that there are particular advantages to using Stratienko's lock in the Eckrote-Lumpkins combination. While Eckrote describes the idea of blocking movement of the arm by a controller controlling the hydraulic fluid flow to the actuator (EX1006, 10:60-11:12), Stratienko recognizes that fluid leak across the seals in the cylinder could still cause unwanted movements of the arm, e.g., hydraulic drift. EX1008, 1:22-27. As described above, the leakage of fluid through the seals of the valves and the compressibility of hydraulic fluid can lead to small but unwanted movements of the hydraulic cylinder rod, even when hydraulic controls are used to prevent or block movement. *Supra* §VI.B.4.

230. A POSITA would have understood that during grading operations, any inadvertent movement of the vehicle arm caused by fluid leak in the cylinder

would move the blade relative to the ground, causing the resulting grading to be out of specification for the job. As I described above, a POSITA would have known and expected the forces exerted on the grading blade during a grading operation to be comprised of horizontal and vertical components because of the way the blade interacts with the surface of the earth/ground. *See supra* §VII.C.1.a (discussion of the horizontal load applied to a blade during grading operations). As previously discussed, the horizontal force would be in the opposite direction of the propulsive force of the vehicle, and the vertical (upward) force would be opposed by the forces exerted on the skid-steer arms (e.g., locking or movement blocking forces described herein). Grading during these typical types of loading and undesirable blade movement scenarios would be inefficient and costly because graded areas may need to be re-graded if the inadvertent arm movements (including up and down movements of the arms that are possible due to hydraulic fluid leakage or compressibility) cause the grading to deviate too far from the requirements for the site. EX1007, [0003] ("Instead of evenly leveling the terrain, a bulldozer tends to reproduce the very rough terrain over which it drives" when the bulldozer chassis and blade move up and down during grading), [0010] ("What is also needed is a system that permits the operator to grade faster by automatically controlling blade pitching"), [0034]; *see also* EX1004, [0002] ("the ground has to be leveled with high accuracy").

231. Further, a POSITA would have understood that while Lewis's hydraulic control is susceptible to fluid leakage within the valve that would allow some movement of the cylinder and lift arm, Stratienko's mechanical lock has no such susceptibility. *See* §VI.B.4, *supra*. A mechanical lock—such as the cylinder lock Stratienko teaches—solves the problem of movements due to fluid leakage, as well as others that would arise due to inadvertent lift arm movements. For example, locking the lift arm in a position with Stratienko's cylinder lock would prevent grading inaccuracies that would result from the small and unwanted movements of the arm. Additionally, locking the lift arm in a position with Stratienko's cylinder lock would provide a failsafe by preventing the arm movements that might result in unpredictable movement of the lift arm and objects on the ground that might be impacted by the arm during the small movements, such as stones.

232. Further still, Stratienko describes that mechanical locks are durable, and that his specific design is compact, simple, and inexpensive. EX1008, 1:29-31; 2:3-6; 2:67-3:1. A POSITA reading Stratienko would have understood that the lock would be simple to install and economical to manufacture because of its simple design. Stratienko describes that the cylinder lock "is used in conventional hydraulic actuators" (*id.*, 2:34-35) and "is universally adaptable to standard hydraulic actuators and can be easily adapted to fit different size rods for a

particular hydraulic actuator." *Id.*, 3:3-6. By providing a lock that can be used with existing hydraulic actuators, Stratienko's lock would be applied to vehicles in the field without any need to retrofit or otherwise upgrade the vehicle. A POSITA would have appreciated that applying Stratienko's teaching of a simply installed and inexpensive lock would be straightforward and would be well-worth the expected outcome of blocking even minor movements of the lift arm.

233. A POSITA would have been motivated by such advantages to use Stratienko's lock teaching with the Eckrote-Lumpkins design to prevent inadvertent movement of the lift arm, as described above. A POSITA would have appreciated that instead of, or in addition to, using Eckrote's controller to block the arm from raising off from the stop, the cylinder lock taught by Stratienko would have been used to the same or similar effect, while eliminating any undesirable effects of hydraulic fluid leaking. Even if the hydraulics supporting and controlling the main arm were to experience hydraulic fluid leakage, Stratienko's cylinder lock would mechanically prevent the retraction or extension of the hydraulic cylinder rod and thereby prevent movement of the main arm. A POSITA would have had at least a reasonable expectation of success because the combination integrates highly predictable mechanical systems. Additionally, a POSITA would recognize that this mechanical and hydraulic combination will produce predictable results with known performance.

B. Claim Element Analysis

1. Claim 1

Element [1.pre] A method for controlling a dozer blade controlled by an automatic grade control system on a skid steer vehicle comprising:

Element [1.1] providing a skid steer vehicle having a main arm with a front side operably coupled to a dozer blade assembly;

Element [1.2] providing a stop connected to the skid steer vehicle upon which a point of the main arm rests thereby defining a lower limit of movement of the main arm;

Element [1.3] positioning the point of the main arm against the stop;

234. The Eckrote-Lumpkins-Stratienko combination renders obvious Elements [1.pre], [1.1], [1.2] and [1.3] and Claim 1 as a whole for the same reasons discussed above at §XII.D Elements [1.pre], [1.1], [1.2], [1.3].

Element [1.4] preventing the ability of the main arm from providing any lifting force by restricting the ability of a hydraulic that lifts the main arm;

235. The Eckrote-Lumpkins-Stratienko combination renders obvious Element [1.4] and Claim 1 as a whole. As discussed, this combination incorporates Stratienko's disclosure of an automatically operated "infinite position type" mechanical hydraulic cylinder rod lock as a supplemental means of immobilizing the main arm of the Eckrote-Lumpkins skid-steer vehicle in a lowered position against a stop. EX1008, 1:62-63; *see also id*., 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §XIII.A.1 (motivation-to-combine). The infinite position lock ***prevents movement of the***

hydraulic cylinder rod thus ***restricting its ability to move*** the lift arm and ***preventing any movement*** (such as a lifting force) ***of the lift arm***.

236. Accordingly, as a POSITA would have understood, in the Eckrote-Lumpkins-Stratienko combination, when Stratienko's mechanical lock grips the rod of the hydraulic cylinder actuator controlling the main arm, the ***main arm is prevented from providing any lifting force*** because the ***hydraulic that lifts the main arm is restricted*** from moving. §XII.A (combination).

Element [1.5] operably connecting the automatic grade control system to a hydraulic that controls a pitch axis of movement of the dozer blade to affect a height of the dozer blade relative to a ground surface.

237. The Eckrote-Lumpkins-Stratienko combination renders obvious Element [1.5] and Claim 1 as a whole for the same reasons discussed above at §XII.D Element [1.5].

2. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

238. The Eckrote-Lumpkins-Stratienko combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole. As discussed, this combination incorporates Stratienko's disclosure of an "infinite position type" mechanical hydraulic cylinder rod lock for immobilizing the main arm of the Eckrote-Lumpkins skid-steer vehicle in a lowered position against a mechanical stop.

EX1008, 1:62-63; *see also id.*, 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §XIII.A.1 (motivation-to-combine). As a POSITA would have understood, in the Eckrote-Lumpkins-Stratienko combination, Stratienko's infinite position lock prevents the rod of the arm assembly hydraulic cylinder from axial movement, so that there is no extension or retraction of the rod. Without extension or retraction of the hydraulic cylinder rod, there is no movement of the lift arm because the hydraulic cylinder rod is not operable to raise or lower the lift arm from its position. Stratienko's infinite position lock thus locks the main arm in place by preventing the main arm from moving. EX1008, 5:40-62. Accordingly, a POSITA would have understood that in the Eckrote-Lumpkins-Stratienko combination, engaging Stratienko's mechanical hydraulic cylinder rod lock with the arm actuator ***locks the main arm against the stop*** at the ***lower limit of movement of the main arm***. §XII.A (combination).

3. Claim 3

[3.pre] The method for controlling a dozer blade as in claim 1 further including:

[3.1] operating a valve to hydraulically isolate the hydraulic lift that lifts the main arm to further prevent any movement of the main arm.

239. The Eckrote-Lumpkins-Stratienko combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole, including for similar reasons discussed above at §XII.D Elements [1.2], [1.3], and [1.4]. As discussed above,

this combination incorporates Stratienko's disclosure of an automatically operated "infinite position type" mechanical hydraulic cylinder rod lock as a supplemental means of immobilizing the main arm of the Eckrote-Lumpkins skid-steer vehicle in a lowered position against a mechanical stop. EX1008, 1:62-63; *see also id.*, 2:33-3:9, 3:50-4:36, 5:14-60, Figs. 3-4, *supra*, §IX.A (summary of Stratienko), §XIII.A.1 (motivation-to-combine).

240. In the Eckrote-Lumpkins-Stratienko combination, a POSITA would have been motivated to apply Stratienko's cylinder lock ***in addition to*** Eckrote's controller controlling the hydraulic fluid flow to the arm actuator to block movement of the arm. EX1006, 10:60-11:12; *supra* §XII.A (summary of Eckrote), §XIII.A (combination). Locking the hydraulic cylinder rod to prevent any movement of the cylinder, based on Stratienko's teaching of the infinite position lock, prevents the small and unwanted movements of the hydraulic that can occur when there is leakage around the valve. Stratienko's cylinder lock provides an additional mechanism for preventing movements of the lift arm, taking into account the realities of hydraulic systems of which a POSITA would have been well-aware. A POSITA, knowing that leakage of hydraulic fluid can occur, would have been motivated to implement Stratienko's cylinder lock with Eckrote's hydraulic control to block movement of the main arm during grading operations.

241. As explained above, a POSITA would have understood that controlling hydraulic fluid flow to and from the arm actuator hydraulic cylinder to block arm movement might still lead to unintentional movements when fluid leaks across seals in the system and would have been motivated to employ both hydraulic and mechanical locks as a result. EX1008, 1:22-27; *see also supra* §VI.B.3.

242. A POSITA would have understood that there is little downside to using Stratienko's lock as a redundant locking mechanism in the Eckrote-Lumpkins-Stratienko combination because Stratienko's lock can be used with any standard cylinder and is both cheap and easy to install. EX1008, 1:29-31; 2:3-6; 2:67-3:1. From a POSITA's perspective, it would have been apparent or obvious to operate Eckrote's controller to instruct the valve assembly to output a signal to ***operate a valve***. EX1006, 10:12-16 ("the controller 402 is configured to instruct a valve assembly 408 to control hydraulic fluid flow from a hydraulic fluid source 410 to the at least one arm actuator 116, which is configured to raise and lower the arms of the arm assembly"), 10:60-11:12; *supra* §VI.B.3. It would have also been obvious to a POSTA that blocking fluid flow to and from the hydraulic lift cylinders results in ***hydraulically isolating*** the cylinder, and therefore preventing actuation of, the ***hydraulic lifts that moves the main arms***.

243. It would have further been obvious to a POSITA to utilize ***both*** mechanical locking systems (like Stratienko's cylinder lock) and hydraulic locking mechanisms (like Eckrote's hydraulic control system) to prevent the movement of the arm during grading for safety reasons and for reasons of efficiently performing required work. A POSITA would have understood that additional and separate mechanisms are applied to important systems as a matter of routine practice to improve safety and ensure continued operation of equipment in the case of failure. *Supra* VI.B.5.

244. In general, multiple (often redundant) mechanisms are used at worksites, where possible, to eliminate hazards and prevent accidents that could harm human workers or disrupt work flow. Using more than one mechanism to lock a lift arm in place can in some situations improve safety and efficiency at the worksite by providing redundancies that protect against failure or prevent operator error or oversight. When an additional and separate mechanism is easy and economical to implement, as is the case with Stratienko's lock, a POSITA would have been motivated to incorporate it as a matter of routine. EX1008, 1:29-31; 2:3-6; 2:34-35; 2:67-3:1; 3:3-6.

245. Additional, separate mechanisms can also provide alternative mechanisms to ensure that equipment remains operational in case of failure of a first mechanism. The presence of equipment and operators at a worksite can be

costly, and when equipment fails and requires repair the equipment cannot be operated at the worksite, resulting in slow-downs in accomplishing the job at the worksite. By providing multiple mechanisms for keeping the lift arm from moving from a lowered position, a POSITA would have understood that in the case of a failure of one of the mechanisms, work could continue relying on the second mechanism. Grading at the worksite could continue and the project could remain on schedule despite the failure of one system.

246. Accordingly, a POSITA would have understood that in the Eckrote-Lumpkins-Stratienko combination, Eckrote's controller ***blocks movement of the arm*** using ***a valve*** assembly to block the flow of hydraulic fluid to the arm actuator, thereby ***hydraulically isolat[ing] the hydraulic lift that lifts the main arm***. *Supra*, §XII.D Elements [1.2], [1.3], [1.4], and [3.1]; EX1006, 10:12-28, 10:60-11:12, Fig. 4.

4. Claim 4

Element [4.pre] The method for controlling a dozer blade as in claim 3 further including:

Element [4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

247. The Eckrote-Lumpkins-Stratienko combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §XII.D Elements [3.1] and [2.1].

XIV. GROUNDS 2C—OBVIOUSNESS OVER ECKROTE, LUMPKINS, ORSER

248. Ground 2C is substantively identical to, and incorporates the analysis of Ground 2A, for several claim elements. Orser's supplementary teachings provide an additional/alternative basis for finding Elements [2.1] and [4.1] satisfied and obvious in view of the claims as a whole. Integrating Orser's supplementary teachings with respect to Elements [2.1] and [4.1] here in Ground 2C does not alter the features of Eckrote and Lumpkins mapped to the other claim elements in Ground 2A.

A. The Eckrote-Lumpkins-Orser Combination

249. The Eckrote-Lumpkins-Orser combination represents the predictable result of applying Orser's supplemental teachings about a mechanical lift arm lock to the Eckrote-Lumpkins combination, which provides for blocking movement of the main arm of a skid-steer from a lowered position on the stops during automatic grading. As illustrated below, the teachings of Eckrote, Lumpkins, and Orser would have been combined by a POSITA to implement Eckrote's skid-steer with an automatic grade control system as Lumpkins teaches (as described above, *see supra* §XII.C) and to mechanically lock the main lift arm to the stops on the chassis as Orser teaches.

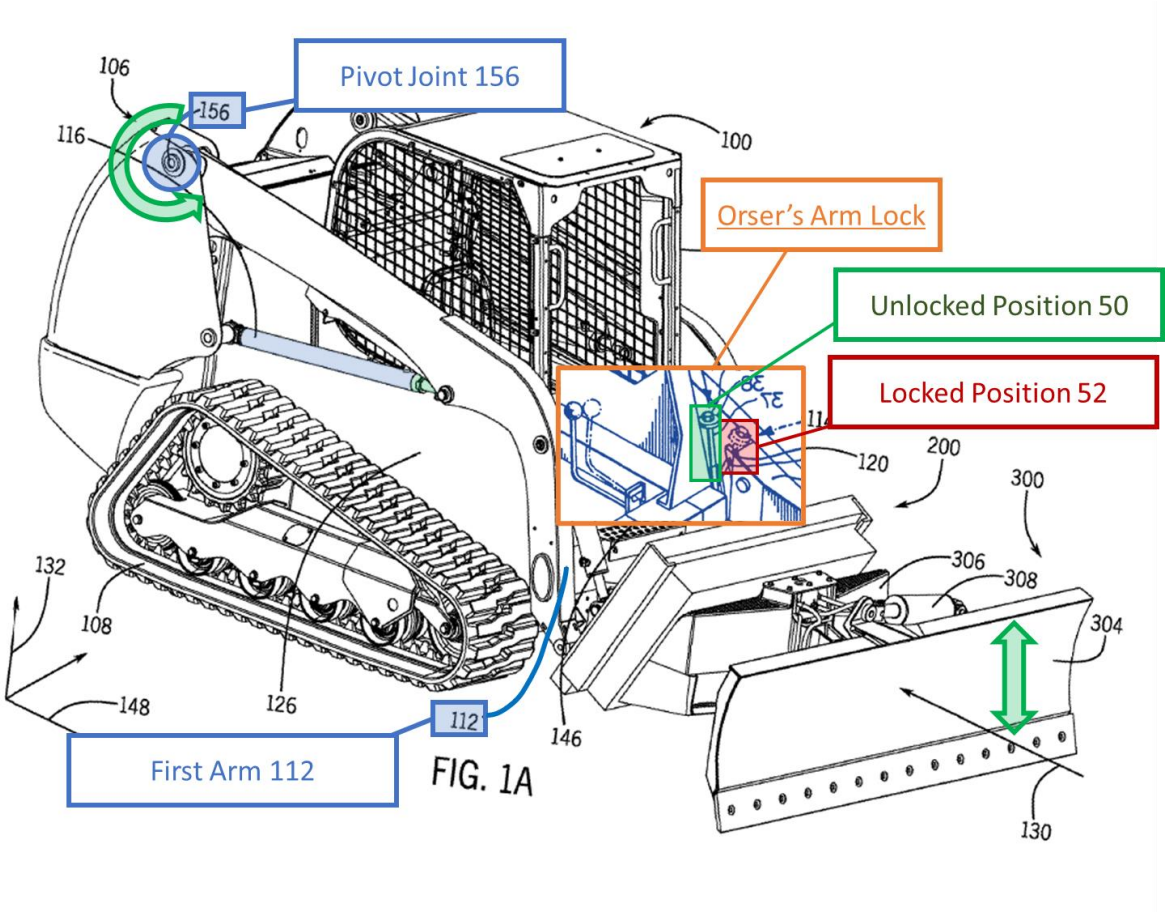


FIG. 1A

EX1006, Fig. 1A (modified to reflect the combination with Lumpkins and Orser)

250. In effect, Orser's lock provides a mechanism for mechanically locking the main lift arm of the skid-steer to the stops in the lowered position in the Eckrote-Lumpkins combination. EX1009, 2:9-14. In this combination, Orser's teaching to use mechanical lock to lock the lift arm to the stops is combined with the teachings of Eckrote-Lumpkins (described above). I do not propose physically integrating the devices described in the references. Further, the combination does not require incorporation of the physical structures of one reference into the other.

1. Reasons to Combine

251. From a POSITA's perspective in 2018 applying the supplemental teachings of Orser in this way would have involved nothing more than applying a known solution to the known problem of preventing movement of the main arm—a problem acknowledged by Eckrote's teaching to "block movement of the arms" to ensure they remain in the lowered position. EX1006, 10:60-11:12. A POSITA would have been aware of mechanical locks as a known method for fixing a moving component in place and would have been motivated to apply this known method to the known issue of unwanted lift arm movement.

252. The fundamental aspects of Eckrote's disclosure would remain intact, bolstered by the well-known and beneficial teachings of Lumpkins to use an automatic grading control system and of Orser to mechanically lock the main arm to the stop, thereby arriving at the '300 patent's claimed invention. Eckrote's teachings about using a controller to instruct a valve to block or allow hydraulic fluid to flow to a hydraulic cylinder responsible for adjusting the lift arm and Lumpkins' teachings about vehicles with automatic grade control systems for adjusting the position of a blade during pitching of the vehicle would not be impacted by the implementation of Orser's teaching to use a mechanical lock to hold the lift arms in a lowered position. Instead, the teachings, implemented

together, would work toward a similar purpose of grading by adjusting a dozer blade height while keeping the lift arms locked in a lowered position.

253. A POSITA would have been motivated to pursue the Eckrote-Lumpkins-Orser combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

e. Preventing Unwanted Lift Arm Movement

254. Eckrote's teaching to block movement of the arm with a controller that controls hydraulic fluid flow to the arm actuator would have prompted a POSITA to look to references, such as Orser, that disclose solutions to the problem of "[b]lock[ing] upward movement of the arm." EX1006, 10:60-11:12, 10:12-28; EX1009, 2:9-14. Eckrote's teaching to use hydraulic controls to "block" movement of the lift arm in the lowered position would have prompted the POSITA to look for other means to prevent movement of the lift arms. EX1006, 10:60-11:12. A POSITA would have appreciated that Orser provides a mechanism "for selectively locking the lift arm to the vehicle body in the lowered position." EX1009, Abstract, *see also* Title ("Lift Arm Lock Down Apparatus and Method"). A POSITA, looking for ways to lock the lift arm in the lowered position as Eckrote describes, would have looked to references such as Orser and found a suitable solution.

f. Known Solution to the Problem

255. A POSITA would have understood that mechanically locking a main arm to the chassis of the skid-steer is a known technique for solving the problem that Eckrote's teaching introduces—to block movement of the main arm. Orser describes that other locking devices were known for use in locking the boom or arm of a vehicle to prevent movement of the same. *See* EX1009, 1:5-2:8. A POSITA would have understood that Orser's mechanical arm lock presents a suitable solution to the problem of unwanted lift arm movements—either in place of or in conjunction with Eckrote's suggestion to control hydraulic fluid flow to the arm actuator—because Orser's arm lock is specifically designed to work with an arm of a skid-steer. EX1009, 3:32-44, Figs. 1-2; EX1006, 2:66-3:4 ("the work vehicle 100 is a skid steer…the work vehicle 100 includes a cab 102, a chassis 126, and an arm assembly 106"), 10:64-65 ("the controller may block movement of the arms"), *see also id*., 3:25-4:47, 10:12-28, Figs. 1A, 4.

256. In particular, Orser describes "a lift arm lock down apparatus…which provides for the locking of the lift arm of a front end loader… to the vehicle body in a lowered position of the lift arm [so that] raising of the lift arm is substantially prevented." EX1009, 2:9-14, *see also id.*, 2:33-39, 2:67-3:9, 3:28-49. Orser's lock is "adapted to secure lift arm 12 to body 16 in a lowered position." EX1009, 3:37-38. A POSITA would have been motivated to use Orser's lock for this purpose as

a suitable addition to the Eckrote-Lumpkins design to prevent the main arm from moving.

g. Known and Predictable Advantages

257. As discussed above in §X.B.1 (Ground 1C combination), a POSITA would have appreciated that the Orser arm lock has particular advantages when used in combination with a hydraulic control mechanism. This combination eliminates the detrimental effects of fluid leakage in the hydraulic valve and hydraulic lift cylinder, and also eliminates any undesirable movement of the lift arm (and therefore the dozer blade) due to lost motion in the pivot joints of the lift arms and hydraulic cylinders. *See also supra* §VI.B.4. A POSITA would have understood that the use of Orser's mechanical arm lock eliminates the detrimental effects of fluid leakage in the hydraulic valve and hydraulic lift cylinder, and also eliminates undesirable movement of the lift arm (and therefore the dozer blade) due to lost motion in the pivot joints of the lift arms and hydraulic cylinders. *Id*.

258. A POSITA would have recognized that the advantage of having Orser's arm lock as an additional mechanism to secure the main arm in the lowered position that can be used independently from the hydraulic cylinders applies to its use in the Eckrote-Lumpkins combination. EX1009, 2:19-26 ("It is an advantage of a lift arm lock down apparatus in accordance with this invention, that it may be employed independently of whether the lifting cylinder rod of a lift arm to be

locked down must be prevented from retracting or extending, since the lock down apparatus is independent of such a lifting cylinder rod and connects the lift arm itself with the vehicle frame and body"). A POSITA would have understood that it is typical to employ multiple mechanisms to provide redundant backups in important systems. A POSITA would have also understood that a mechanical lock would be useful in cases when the hydraulics are not engaged such as during transport on a truck bed or trailer. During transport, the mechanical lock would prevent potential arm movement when a trailer experiences unexpected shifts or bouncing.

259. A POSITA would have also understood that for similar reasons as discussed above, Orser's arm lock provides a redundancy to Eckrote's control of hydraulic fluid flow to the arm actuator that provides additional measures that allow operators of Eckrote's skid-steer to prevent movement of the main arm during grading or maintenance. EX1009, 1:13-37, 2:1-9; *see also* EX1008, 1:22-27, 5:68-6:14; *see also supra* §VI.B.5. The redundant locking mechanism provides additional confidence to those outside the cab of the skid steer, for example, when personnel are working in close proximity to the dozer blade and guiding the skid-steer operator's actions. Orser's arm lock can be conveniently engaged from within the operator's cabin without requiring the operator to leave the operator's seat or exit the skid-steer. EX1009, 5:68-6:14. A POSITA would have been

motivated by such advantages to use Orser's arm lock with the Eckrote-Lumpkins design to secure the arm in the lowered position.

260. A POSITA would have appreciated that instead of, or in addition to, using Eckrote's hydraulic control system to block movement of the arm and keep the arm on the chassis stop, the mechanical arm lock described by Orser would have been used to the same or similar effect.

B. Claim Element Analysis

1. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

261. The Eckrote-Lumpkins-Orser combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole. As discussed, this combination incorporates Orser's disclosure of an arm lock as a supplemental means of securing the main arm of the Eckrote-Lumpkins skid-steer in the lowered position against the mechanical stop. EX1009, 2:1-14; *see also id*., 3:32-44, 1:13-37, Figs. 1-2; *supra*, §X.A (summary of Orser), §XIV.A.1 (motivation-to-combine).

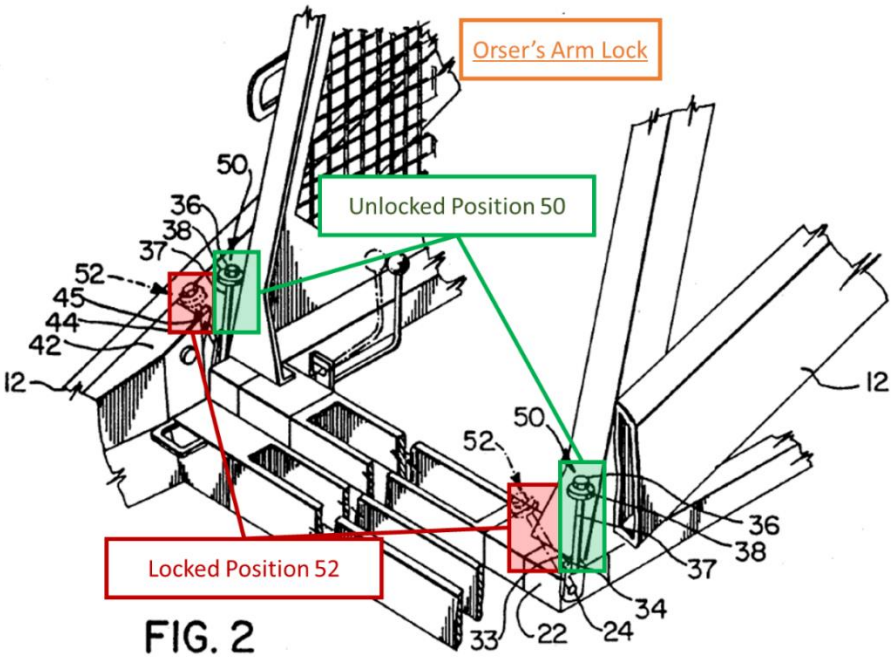


FIG. 2

EX1009, Fig. 2 (annotated)

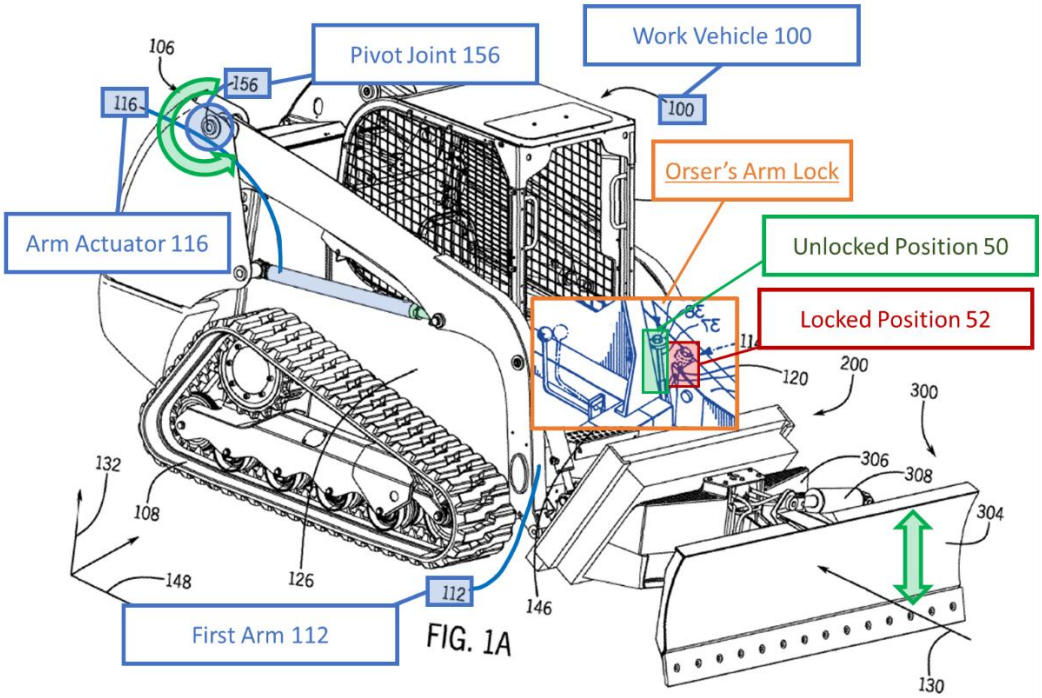


FIG. 1A

EX1006, Fig. 1A (annotated)

262. Orser provides a teaching of a mechanical "lift arm lock down apparatus" that includes "a lock for selectively securing the lift arm to the vehicle body, when lowered." EX1009, 2:30-36. The lock "lock[s] down a lift arm" by "fixing the lift arm to the vehicle body by means of a lock, when the lift arm is lowered." EX1009, 2:40-46.

263. Implementing Orser's teaching to use a lock to keep the lift arm in the lowered position in the Eckrote-Lumpkins system would have resulted in locking the lift arm against the stop when the lift arm is in the lowered position (i.e., when the lift arm is at the lower limit of movement of the arm). EX1009, 2:30-36; 2:40-46; EX1006, 3:53-55 ("The work vehicle may include mechanical stops to support the arms of the arm assembly 106 while the arms are in the lowered position."). Accordingly, as a POSITA would have understood, in the Eckrote-Lumpkins-Orser combination, when Orser's arm lock is engaged, the main arm is secured against the stop, "***locking the lift arm*** to the vehicle body in the ***lowered position***." EX1009, Abstract, 1:6-11, 4:19-27; §XIV.A (combination).

2. Claim 4

[4.pre] The method for controlling a dozer blade as in claim 3 further including:

[4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

264. The Eckrote-Lumpkins-Orser combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §XII.D Element [3.1] and §XIV.B Element [2.1].

XV. GROUND 2D—OBVIOUSNESS OVER ECKROTE, LUMPKINS, STRATIENKO, ORSER

265. Ground 2D is substantively identical to, and incorporates the analysis of Ground 2B, for several claim elements. As discussed at Ground 2C, Orser's supplementary teachings provide an additional/alternative basis for finding Elements [2.1] and [4.1] satisfied and obvious in view of the claims as a whole. Integrating Orser's supplementary teachings with respect to Elements [2.1] and [4.1] here in Ground 2D does not alter the features of Eckrote, Lumpkins, and Stratienko mapped to the other claim elements in Grounds 2B.

266. A POSITA would have been motivated to apply Orser's supplemental teachings about a mechanical arm lock for securing the main arm to a skid-steer body to the Eckrote-Lumpkins-Stratienko combination, which provides for immobilizing the main arm of a skid-steer in a lowered position during automatic grading by control of hydraulic fluid flow to the arm actuator and an infinite

position cylinder lock. §XIII.A. Although Orser's mechanical arm lock provides an additional mechanical locking mechanism to the Eckrote-Lumpkins-Stratienko combination, Orser's mechanical lift arm lock is manually actuated and would have provided a simple locking mechanism for operators of the skid-steer in addition to the power-assisted cylinder lock taught by Stratienko. A POSITA would have understood that the additional mechanical arm lock taught by Orser provides an additional and advantageous redundancy to the mechanisms for securing the arm in the Eckrote-Lumpkins-Stratienko combination (i.e., controlling hydraulic fluid flow to prevent flow to the cylinder and mechanically locking the cylinder rod). A POSITA would have understood that Stratienko's teaching of a cylinder rod lock would not protect against lost motion occurring in the pin joints of the lift arm or at the coupling of the lift arm to the chassis or where the cylinder connects to the lift arm – it would only immobilize the lift arm itself from raising or lowering due to hydraulic actions. *Supra* §VI.B.4. As such, a POSITA would have been motivated to look to other references like Orser to provide additional protections against inadvertent movements from lost motion in the system.

267. For example, because Orser's mechanical lock operates independently from the hydraulics of the system, the lock provides additional security that the arm will not unexpectedly move. Orser's mechanical lock prevents unintentional and undesirable movements of the lift arm resulting from leakage of hydraulic

fluid at the valve, but also prevents movements of the lift arm that are unrelated to compression or leakage of hydraulic fluid. A POSITA would have understood that Orser's mechanical lift arm lock also prevents unintended and undesirable movements resulting from lost motion between linkage components of the lift arm assembly as well as between the arm and the chassis. A POSITA would have been motivated to combine and implement the Eckrote-Lumpkins-Stratienko system with the addition of Orser's teaching to use a mechanical lock for at least this reason.

268. Additionally, a POSITA would have appreciated the benefits of combining both the hydraulic lock and the mechanical lock because the mechanical lock does not suffer from leakage through the valve. A POSITA would have understood that use of multiple mechanisms for securing the arm in a lowered position would provide backup options for preventing inadvertent movement of the main arm, and further would offer redundant protections to an operator during maintenance or operation of the skid-steer. EX1009, 1:13-37, 2:1-9, 5:68-6:14; *see supra* §VI.B.5.

269. Additionally, a POSITA would have understood that the cost associated with delays for equipment repair during a grading operation with labor on site is expensive. When a vehicle is not operational and needs repair, the job may be delayed at high cost. A POSITA would have been motivated to take

precautionary actions that prevent the vehicle from being taken out of service when there is a failure of an important mechanism (like holding the lift arm in the lowered position), especially when the additional and separate mechanisms are simple and economical to install in existing vehicles, as is the case with Orser's mechanical lock. A POSITA would have been motivated to implement Orser's lock in addition to Stratienko's cylinder lock and Eckrote's hydraulic control system as a low-cost redundancy that provides a mechanical option separate from the hydraulic system so that, in the case of failure of one of the other mechanisms for preventing movement of the arms, delay and cost would be minimized. Additionally, limiting the motion of the lift arms reduces the wear that occurs in the pins of the lift arms over time with use.

270. A POSITA would have appreciated that in addition to Eckrote's control of the hydraulic fluid flow to keep the main arm on the chassis stop and Stratienko's cylinder rod locking mechanism, the mechanical arm lock of Orser would have been used to provide additional assurance that the main arm would not inadvertently move during operation (including during grading) or during maintenance.

A. Claim Element Analysis

1. Claim 2

[2.pre] The method for controlling a dozer blade as in claim 1 further including:

[2.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

271. The Eckrote-Lumpkins-Stratienko-Orser combination renders obvious Elements [2.pre] and [2.1] and Claim 2 as a whole for the same reasons discussed above at §XIV.B.

2. Claim 4

[4.pre] The method for controlling a dozer blade as in claim 3 further including:

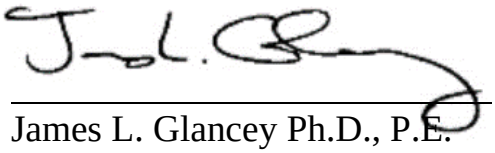
[4.1] locking the main arm against the stop when the main arm is at the lower limit of movement of the main arm.

272. The Eckrote-Lumpkins-Stratienko-Orser combination renders obvious Elements [4.pre] and [4.1] and Claim 4 as a whole for the same reasons discussed above at §XIII.B Element [3.1] and above at §XV.A Element [2.1] (which cross-references §XIV.B).

XVI. CONCLUSION

273. I declare that all statements made in this Declaration of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements are 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).

Dated: 18 September 2024



James L. Glancey Ph.D., P.E.

Appendix A

JAMES L. GLANCEY, PH.D., P.E.

CURRICULUM VITAE (SINCE PROMOTION TO ASSOCIATE PROFESSOR IN 1997)

REGISTERED PROFESSIONAL ENGINEER (MECHANICAL): DELAWARE REG. NO. 19743

EDUCATION

- Ph.D. University of California, Davis 1991
- M.S. University of California, Davis 1987
- B.S. University of Delaware 1985

PROFESSIONAL EXPERIENCE

- Professor, Mechanical Engineering & the College of Agriculture and Natural Resources, University of Delaware 7/12 - present
- Associate Professor, Mechanical Engineering, University of Delaware 9/97 – 6/12
- Associate Professor, Bioresources Engineering, University of Delaware 7/97 – 6/12
- Assistant Professor, Bioresources Engineering, University of Delaware 1/91 - 6/97
- Principle and Owner, Mechanical Design and Forensic Analysis LLC, Middletown, DE 6/99 – present
- Partner, Structural Mechanics Associates, Haverford, PA 7/12 – 6/19

OTHER ACADEMIC APPOINTMENTS

- Academic Contact, Concentration in Manufacturing Systems, Dept. of Mech Engr. 9/18 - present
- Faculty Coordinator, Student Machine Shop, College of Engineering 7/16 – present
- Faculty Advisor, Resilient Builds Engineering Club, College of Engineering 8/18 – present
- Faculty Advisor, Trap and Skeet Club, University of Delaware Chapter 8/17 – present
- Faculty Advisor, Alpha Gamma Rho, Univ. of Delaware Chapter 9/15 - present
- Affiliate Faculty, Center for Composite Materials, Univ. of Delaware 7/03 - present
- Engineer, Cooperative Extension Service, Univ. of Delaware 7/03 - present
- Faculty Member, Center for Biomedical Engineering Research, Univ. of Delaware 9/03 – present
  (now the Center for Biomechanical Engineering Research, Univ. of DE)

RECOGNITION AND AWARDS

- The University of Delaware George M. Worrilow Award for Outstanding Alumni. 2017.
- The Delaware Farm Bureau Distinguished Service to Agriculture Award. 2014.
- The Water Resources Association of the Delaware River Basin's 2011 Government Award - (co-recipient with Governor Jack Markell; Secretary of Environment and Energy Collin O'Mara; Secretary of Agriculture for the State of Delaware, Edwin Kee; Mayor of Middletown, Delaware, Kenneth Branner; and President of Artesian Water, Dian Taylor). 2011.
- The Delaware Vegetable Growers Association Distinguished Service Award. 2011.
- Selected as Associate Editor, Power and Machinery Division, The American Society of Agricultural and Biological Engineers, 2004-2012.
- Nominated for Excellence in Academic Advising, University of Delaware, 2006.
- Inducted into the University of Delaware's Mentors' Circle. 2001.
- Dean's Merit Award, University of Delaware, 2001.
- Nominated for Excellence in Teaching Award, University of Delaware College of Engineering, 2000.
- North Central Campus Senior-Faculty Recognition Award, University of Delaware, 2000.
- Excellence in Academic Advising, University of Delaware. 1997.
- Society of Automotive Engineers Recognition Award. 1997, 2004 Off-Highway and Powerplant Exposition.
- *Awards Received by Student Advisees:*
  - Solar Decathlon Event Sponsored by NREL, UD College of Engineering Team Submission. 2021. Top Ten Finalist.
  - American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2019. Harper Drake, Mary Galanek, John Hughes, Jess Tentindo. $500.
  - American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2013. Benjamin J. Hockman, Gerad M. Lieb, Gregory N. Ohnemus, Luke A. Walmer. $500.

986 CHURCHTOWN ROAD
MIDDLETOWN DELAWARE 19709
USA

304 PILOTTOWN ROAD
LEWES DELAWARE 19508
USA

302.690.7531

- American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2013. Brett A. Davis, David L. A. Eisensmith, Laura E. Quinn, Stephen J. Schafer. $500
- The 2009 American Society of Mechanical Engineers (ASME) International Student Design Competition, Second Place Award Recipients (Raquel Ciappi, Brad Miller, Steve Petfield, Chris Uthgenannt). $1000.00.
- The 2008 ASME International Student Design Competition, Tied for First Place Award (Sean Collins, Sarah Mabel, Dan Shannon, and Doug Erikson). $2,500.
- The 2008 ASME International Student Design Competition, Tied for First Place Award (Jess Dibelka, Julianne Twomey, and Mark Steimer). $2,500.
- Sigma Xi (University of Delaware Chapter) Undergraduate Research Thesis Award (Janelle Konchar)
- Society for the Advancement of Materials and Processing (SAMPE) 2006 National Research Award (Michael Fuqua, 2nd Place), $1,000.
- Honors Degree with Distinction Thesis (Kerrie Smith, Richard Herseim, Scott Kasprzak, Michael Fuqua)
- Degree with Distinction Thesis (Janelle Konchar, Dan Brisach, Matt Griffith)
- Honors Program Undergraduate Research Summer Fellowship (Scott Kasprzak, Michael Fuqua)
- Hayward Fellowship for Undergraduate Research (Kerrie Smith, Richard Herseim, Scott Kasprzak)
- Nowinski Award for Undergraduate Research in Mechanical Engineering (Rich Herseim)
- Science and Engineering Scholars (Richard Herseim, Ian Cosden, Michael Fuqua, Janelle Konchar, Jessie Krisher, John Nasr, Mathew Griffith, Stephan Petfield, Connie Helstosky)
- Delaware Water Resources Center Summer Internship (Kerrie Smith, Mathew King)
- Undergraduate Research Supply & Expense Grants (Daniel Brisach (2), Matthew Griffith (3), John Nasr, Scott Kasprzak (2), Janelle Konchar (3), Jesse, Krisher, Mike Fuqua (2), Dan Muhlenforth, James Moore, Jennifer Lawrence, Dominic Schiavoni, Eric Busby, Richard Herseim (2), Gwen Thorsen (2), Dustin Fryberger, Kerrie Smith (2), Dawn Cintavey, Tony Nasr, Annie Tseng, Mike Fyock, Dan Meckley, Chad Stover, Dan Hoffstetter) ($5,000 total for all students).
- Colonial Academic Alliance Undergraduate Research Symposium Invited Presenter (Janelle Konchar, Kerrie Smith)
- Center for Biomedical Engineering Research Symposium Presenters (Justin Alms, Jennifer Lawrence, James Moore, Dominic Schiavoni, Dan Muhlenforth, Jonathan Fitzgibbons, Barbara Tuesday, Rich Herseim, Janelle Konchar, Jessie Krisher)
- Center for Composite Materials Undergraduate Research Fellowship (Michael Fuqua, Matt Griffith, Steven Petfield)
- Outstanding Senior Researcher, Center for Composite Materials (Scott Kasprzak, Daniel Brisach)
- Center for Composite Material Graduate Achievement Award (Justin Alms, co-advised w/ S. Advani)
- College of Engineering Graduate Student Laird Fellowship (Jingbo Wang, co-advised w/ J. Vinson)
- Center for Composite Materials R.L. McCullough Scholars Award (Justin Alms, co-advised with S. Advani)

PROFESSIONAL SOCIETIES

- American Society of Mechanical Engineers
- American Society of Agricultural & Biological Engineers
- Society for the Advancement of Material and Process Engineering
- International Society of Beverage Technologists
- Society of Automotive Engineers
- Delaware Association of Professional Enrs
- American Society of Safety Professionals
- American Concrete Pumping Association

TEACHING

COURSES TAUGHT AT UNIVERSITY OF DELAWARE

- EGTE 125/167 Freshman Seminar (96F, 97F, 98F).
- EGTE/BREG 209 Computer-Aided Drafting (06S, 08S, 09S, 10S, 11S).
- EGTE 435 Machinery Design (96F, 98S, 01S, 03S, 05S, 07S).
- EGTE 450 Practicum in Industry (06S).
- EGTE 467 Issues in Production Agriculture (02S).
- EGTE 366/466 Undergraduate Independent Study (01F, 02S, 03F, 04S, 06F, 07W, 07S).
- AGEG 666 Graduate Independent Study (97S).
- BREG 666 Graduate Independent Study (08F, 10S).
- MEEG 202 Computer-Aided-Engineering Design (05S, 11S, 12S).
- MEEG 301 Machine Design: Kinematics (11F - 20F).
- MEEG 304 Machine Design: Elements (99S, 00S, 12S-21S).

- MEEG 401 Senior Design (99F/S, 00F-05F, 07F-21F).
- MEEG 445 Senior Research (00-06).
- MEEG 366/466 Independent Study (06-21S).
- MEEG 467 Special Topics in Engineering Design (03S, 04S).
- MEEG 666 Graduate Independent Study (08S, 09F, 19S).
- MEEG 866 Graduate Research (02F, 03S, 03F, 04S).
- UNIV 111 First Year Experience Freshman Seminar (08F).
- UNIV 401/402 Senior Thesis, University-Wide Instructor of Record (07F, 08S).
- UNIV 401/402 Senior Thesis Advisor (02F, 03S, 03F, 04S, 04F, 05S, 05F, 06S, 06F, 07S).

INVITED LECTURES

- MEEG 653/453, Manufacturing Processes. Two Lectures: *Computer-Aided Engineering and Manufacturing & Automation for Manufacturing.* (2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021).
- MEEG 304, Machine Design. *Developing Design Packages for Communicating Engineering Solutions*. (2008).
- EGTE 440, Plant Layout. *Basics of Vibration and Noise-Related Industrial Hygiene and Engineering Controls to Reduce Exposures and Injuries*. (2007).
- UNIV 401, Senior Thesis. *Developing an Effective Research Presentation: Fall Meeting of the Senior Thesis Candidates.* (2004, 2005, 2006).
- UNIV 401, Senior Thesis. *Using and Not Abusing Technologies to Deliver Research Presentations (a.k.a. Avoiding Death by PowerPoint).* (2005, 2006).
- PLSC 302, Vegetable Science. *Precision Ag for Horticultural Crops*. (2000).
- ANFS 421, Poultry Production. *Pollution Prevention Technologies for the Delmarva Poultry Industry.* (1999).
- PLSC 302, Vegetable Science. *Mechanization & Engineering in Production Horticulture & Introduction to GPS Technologies.* (1999, 2010).
- EGTE 443, Instrumentation. *Basics of GPS and DGPS.* (1998).

GRADUATE AND UNDERGRADUATE THESIS

- Ph. D. Students:
  - First Advisor:
    - Justin Alms, Ph.D. in Mechanical Engineering (with Dr. Suresh Advani, 2006-2010).
      Thesis: Closed Loop Control Strategies with VARTM for Manufacturing Large-Scale Composites.
  - Committee Member:
    - Hao Liu, Ph.D. in Mechanical Engineering (2018)
    - Thomas Cender, Ph.D. in Mechanical Engineering (2017)
    - Hatice Sas, Ph.D. in Mechanical Engineering (2015)
    - Hao Lu, Ph.D. in Mechanical Engineering (2014)
    - John Gandolf, Ph.D. in Mechanical Engineering (2014)
    - Parag Nittur, Ph.D. in Mechanical Engineering (2013).
    - Thomas Cender, Ph.D. in Mechanical Engineering (2013).
    - Hatice Sas, Ph.D. in Mechanical Engineering (2013).
    - Liang Chen, Ph.D. in Mechanical Engineering (2010).
    - Swapnil Garge, Ph.D. in Chemical Engineering (2007).
    - Kalyan Mankala, Ph.D. in Mechanical Engineering (2006).
    - Jeff Lawrence, Ph.D. in Mechanical Engineering (2005).
    - Jie Sheng, Ph.D. in Mechanical Engineering (2005).
    - Chris Foster, Ph.D. in Mechanical Engineering (2005).
    - Xiangyu Wang, Ph.D. in Mechanical Engineering (2004).
    - Luis Crespo, Ph.D. in Mechanical Engineering (2002).

- M.S. Students:
  - First Advisor:
    - Ajit R Nalla, Master in Mechanical Engineering (2006).
      Thesis: Modeling and Adaptive Control of Vacuum Assisted Resin Transfer Molding Systems with Segmented Injection and Vacuum Lines.

- Jingbo Wang, Master in Mechanical Engineering (with J. Vinson, 2002),
  Thesis: Transverse Shear and Non-Linear Deformation Effects on the Physical Properties of Sandwich and Laminate Composite Plates.
- Manu Krishnan, Master in Mechanical Engineering (with J. Sun, 2000).
  Thesis: Adaptive Control Strategies for Precision Agriculture Machines.

- Committee Member:
  - Jeff Lugo Master of Mechanical Engineering. (2013).
  - Joe Walther, Master of Mechanical Engineering. (2011).
  - Kenneth Okonkwo, Master of Mechanical Engineering. (2010).
  - Piyush Bubna, Master of Mechanical Engineering (2010).
  - Justin Merotte, Master of Mechanical Engineering (2009).
  - Darren Brown, Master of Mechanical Engineering (2008).
  - Prabhas Bhat, Master of Mechanical Engineering (2007).
  - John Fader, Master of Mechanical Engineering (2006).
  - Thomas Shipman, Master of Mechanical Engineering (2006).
  - Stephanie Frangakis, Master of Mechanical Engineering (2005).
  - Sean McIntosh, Master of Mechanical Engineering (2005).
  - Yeliz Karakaya, Master of Mechanical Engineering (2005).
  - Scott Lynch, Master of Environmental and Energy Policy (2004).
  - James Arters, Master of Mechanical Engineering (2004).
  - Rajkiran Madangopal, Master of Mechanical Engineering (2004).
  - Mathieu Devillard, Master of Mechanical Engineering (2003).
  - Mark Lynch, Master in Food & Resource Economics (1998).

- Undergraduate Degree with Distinction and Honors Degree with Distinction Thesis
  - First Advisor:
    - Daniel Brisach, Degree with Distinction in Mechanical Engineering (2006-07).
      Thesis: Vibration Transmission Measurements in the Hand and Arm from Impacting Components.
    - Matt Griffith, Degree with Distinction in Mechanical Engineering (2006-07).
      Thesis: High Strain Rate Characteristics of Mineral Reinforced Polymers.
    - Janelle Konchar, Degree with Distinction in Mechanical Engineering (2005-06).
      Thesis: Modeling & Testing of a New Polymer-Based Impact Tool Design to Reduce Biomechanical Injuries.
    - Michael Fuqua, Honors Degree with Distinction in Mechanical Engineering (2005-06).
      Thesis: A Port Injection System and Controller for VARTM.
    - Scott Kasprzak, Honors Degree with Distinction in Mechanical Engineering (2004-05).
      Thesis: VARTM Flow Modification with Machine Vision and Robotic Control.
    - Richard Herseim, Honors Degree with Distinction in Mechanical Engineering (2003-04).
      Thesis: A Full Scale Apparatus for Measuring the Forces Exerted on the Human Femur During Falls.
    - Kerrie Smith, Honors Degree with Distinction in Mechanical Engineering (2002-03).
      Thesis: An Autonomous Whole Water Column Environmental Monitoring System with Telemetry.

  - Second Advisor:
    - Rossiny Beaucejour (Mechanical Engineering) 2013-14
    - John Eisenbrey (Mechanical Engineering) 2004-05
    - Michael Kutzer (Mechanical Engineering) 2004-05
    - Thomas Shipman (Mechanical Engineering) 2003-04
    - Kristin Huesmann (Mechanical Engineering) 2002-03
    - Karin Wood (Bioresources Engineering) 2002-03
    - Ryan Jost (Food & Resource Economics) 2000-01

  - Third Reader:
    - Yuk-J Leung (Mathematical Sciences) 2012-13
    - Jennifer Bruhns (Computer & Info. Science) 2012-13
    - Casey Casalnuovo (Computer & Info. Science) 2012-13

- Vikramjit Rathee (Biological Sciences) 2012-13
- Matthew Saponaro (Mathematical Sciences) 2012-13
- Ricky Shum (Mathematical Sciences) 2012-13
- Matthew Stagitis (Computer & Info. Science) 2012-13
- Rebecca Aiken (Civil Engineering) 2011-12
- Michelle Allen (Computer Science) 2011-12
- Cory Bart (Computer Science) 2011-12
- Nicholas Troup (Physics & Astronomy) 2011-12
- Stephanie Countess (Civil Engineering) 2010-11
- Kent Davidson (Civil Engineering) 2010-11
- Craig Davis (Civil Engineering) 2010-11
- Geoffrey Dilg (Civil Engineering) 2010-11
- Christine Sutkowski (Civil Engineering) 2010-11
- Nathan Mayercsik (Civil Engineering) 2009-10
- Melissa Stewart (Civil Engineering) 2009-10
- Jeffrey Bosco (Chemical Engineering) 2008-09
- Michael Daugherty (Health & Exercise Science) 2008-09
- Emily Gardinier (Physical Therapy) 2008-09
- Katherine Monahan (Health & Exercise Science) 2008-09
- Jeff Rockwell (Civil Engineering) 2008-09
- Jason Schoenfeld (Health & Exercise Science) 2008-09
- Adam Blomberg (Physics & Astronomy) 2007-08
- Zachary Fry (Computer & Info. Science) 2007-08
- Andrew Gearhart (Computer & Info. Science) 2007-08
- Hailey Guerriero (Physics & Astronomy) 2007-08
- Joshua Kirby (Computer & Info. Science) 2007-08
- Donald Andre Scott (Computer & Info. Science) 2007-08
- Steven Anton (Physics & Astronomy) 2006-07
- Todd Molnar (Mathematical Sciences) 2006-07
- Daniel Osborne (Physics & Astronomy) 2006-07
- Ming-Jay Shiao (Electrical Engineering) 2006
- Patrick Collar (Computer & Info. Science) 2005-06
- Janine Janoski (Mathematical Sciences) 2005-06
- Kathryne Sharp (Mathematical Sciences) 2005-06
- Zachary Loman (Electrical Engineering) 2005-06
- Peter Steijn (Computer & Info. Science) 2005-06
- Ming-Jay Shiao (Electrical Engineering) 2005-06
- Anteneh Anteneh (Computer & Info. Science) 2004-05
- Michael Brennan (Computer & Info. Science) 2004-05
- Lewis Fishgold (Computer & Info. Science) 2004-05
- Ki-Yong Kim (Computer & Info. Science) 2004-05
- Brendan Farmer (Mathematical Sciences) 2004-05
- Michael Lowinger (Chemical Engineering) 2003-04
- Richard Lunt (Chemical Engineering) 2003-04

VISITING SCHOLARS AND STUDENTS

- Guillaume Lecore. 4th Year Plastics & Composites Process Engineering, *Ecole des Mines de Douai*, Douai, France. Automation of the VIPR process for composite manufacturing. (co-advised w/Dr. Suresh Advani). 2009.
- Laurent Garnier, 4th Year Mechanical Engineering, *Ecole des Mines de Douai*, Douai, France. Evaluation of VARTM control strategies to improve resin filling characteristics. (co-advised w/Dr. Suresh Advani). 2008.
- Aude Catry, 4th Year Mechanical Engineering, *Ecole des Mines de Douai*, Douai, France. Evaluation of VARTM control strategies to improve resin filling characteristics. (co-advised w/Dr. Suresh Advani). 2008.
- Benoit Lelievre. M.S., Department of Mechanical Engineering, *Universite de Bretagne Sud*, Lorient, France. Measurement and Control of the Resin Flow in Composite Pre-forms with Flow Disturbances and Variable Permeability. 2003.

- Yuen-Yong Leong, M.S., Electrical Engineering, *Imperial College London*, South Kensington campus, London, England. System Identification and Controller Design for a Hydrostatic Drive New Holland Windrower. 2002.
- Dr. Zhang Zong, Ph. D. Associate Professor, Department of Mechanical Engineering, *Beijing University of Technology*, Beijing, China. Modeling and Experimental Evaluation of the Wear in a Miniature Vane Pump Used for the Evaluation of Hydraulic Fluid Performance. 1999-2001 (w/ Dr. Michael Keefe).

SPECIAL EDUCATIONAL PROGRAMS AND ACTIVITIES

- *Solar Decathlon Competition*. (2000-2001). Nationwide design competition to develop and operate an 800 ft^2 solar powered house – the team consisted of three faculty advisors, 30 students, 40 industrial sponsors, and several technical consultants. The University of Delaware house, along with the 9 other houses from universities in the U.S. and Puerto Rico, was built and operated on the National Mall in Washington, D.C. for a 10-day period in October, 2002. Over 90,000 visitors toured the site, and the U of D house placed sixth in the competition. Faculty Advisors: Drs. Lian Ping Wang, Ajay Prasad, and James Glancey.
- *Travel Abroad Program to California/Mexico*. Winter Session 2002. Co-Sponsored by the Departments. of Plant and Soil Sciences & Bioresources Engineering. Faculty Directors: Ed Kee and James Glancey. Cancelled due to terrorist activities of September 11, 2001.
- *Charter High School Senior Research Project Advisor*
  - Derrek Jones. 2004-05. Performance of a non-contact temperature sensor for avian egg embryo temperature measurement. Senior Research Project for the *Charter School of Wilmington*.
  - Phillip Franklin. 2004-05. Biomechanics of a human climbing a fiberglass step ladder. Senior Research Project for the *Charter School of Wilmington*.
- *Summer Research Internship*
  - Kurt Hayes. 2011. Comparison of flashspun high-density polyethylene fibers to other conventional polymer fabrics for the separation of oil from water. *Rowen University*, Glassboro, DE.
  - Erin McCaul. 2005. Estimating physical properties required for computing the forces on the upper femur during falls. *St. Marks High School*, Wilmington, DE.
- *High School Sophomore Science Fair Project Advisor*
  - Samir Streatfield. 2011-12. Design of a grinder to accelerate composting of food wastes. *Unionville High School*. Delaware Valley Science Fair, Unionville, PA.
  - Amee Raval. 2006-07. Measuring the Heating Value from Several Different Bio-Diesel and E-Diesel Fuels. Sophomore Science Fair for the *Charter School of Wilmington*, Wilmington, DE.
  - Sam Nobles, 2005-06. Testing of Ethanol-Based and Soy Oil-Based Diesel Fuels in Commercial and Industrial Engines. Sophomore Science Fair for the *Charter School of Wilmington*.
  - Shane Furn. 2005-06. Particulate Emission Measurements from Several Biofuels in Commercial and Industrial Engines. S
  - Sophomore Science Fair for the *Charter School of Wilmington*.
- *Coach for the Science Olympiad.* Lectures and Demonstrations on Simple Machines. Mario Musumeci and Adam Smith. (2008).
- *New Castle County Annual Science Fair Judge and American Society of Mechanical Engineers Award Presenter.* (2006, 2008, 2009, 2010). Stanton, DE.
- *Presentations and Career Fairs for High School Student Groups:*
  - Engineering as a Profession. 2012. Middletown High School, Middletown, DE.
  - What's a Professional Engineer? 2008, 2009. Middletown and Appoquinimink High Schools Career Fair.
  - Engineering as a Profession. 2007. St. Marks High School Career Fair, Wilmington, DE.
  - Biomechanics: Engineering for (and of) Humans. 2004. *Outreach seminar for the Resources for Successful Engineers (RISE) program*, Students from the Philadelphia School District, Newark , DE.
  - Who's Really Protecting Me? Engineers Who Design and Develop Products! 2003. *Outreach seminar for the Resources for Successful Engineers (RISE) program*, Students from the Philadelphia School District, Newark, DE.

UNDERGRADUATE STUDENT PROJECTS ADVISED FOR CREDIT (INDEPENDENT STUDY OR HONORS DEGREE REQUIREMENT), 3 CREDITS UNLESS OTHERWISE NOTED

1. Anuj Gandhi. 2019. Scaling of a silica column manufacturing process for gas chromatographs. Sponsored by Advanced Materials Technology, Wilmington, DE. (Graduate Student)

2. Greg Driscoll and Drew McQuiston. 2019. Integration of a cooperative robot into the assembly process for silica-based reactive columns in liquid chromatographs. Newport Manufacturing Site, Agilent Technologies, Wilmington, Delaware.
3. Mary Galanek. 2018. Fatigue analysis of a four bar linkage. Sponsored by Siemen Healthcare Diagnostics. (Honors Degree Requirement).
4. Michael Palmer. 2018. Testing of an angled gear worm drive for medical display devices. Sponsored by Southco Inc., Concordville, PA. (Honors Degree Requirement).
5. Greg Driscoll. 2018. Stepper motor sizing as an alternative drive for a cooperative robot tube feeding system. Sponsored by Newport Manufacturing Site, Agilent Technologies. (Honors Degree Requirement).
6. Drew McQuiston. 2018. Staticially significant testing of a tube singulation mechanism. Sponsored by Newport Manufacturing Site, Agilent Technologies. (Honors Degree Requirement).
7. Kanak Chattopadhyay. 2018. Evaluation of an automated bottle cap torquing system for the filling line of consumables reagent bottles. Sponsored by Siemens Healthineers, Glasgow, DE.
8. Matt Blasi, Tom Celenza, Matt Seitel, Alex Nugent. 2018. Implementation of a cooperative robot for Computer Numerical Control fabrication of Plexiglas shields. Sponsors by Norwalt Design.
9. Luke Szewczak. 2018. Software and laboratory assignment development for the 3-axis Mazak milling machine in Spencer Lab. Sponsored by the Department of Mechanical Engineering (6 credits)
10. Matt Hall, Sarah Ago, and Ricky Hahn. 2018. Redesign of a 3d adjustment system for an optical HASMAT chemical detector. Sponsored by Smith Detection, Edgewood, Maryland.
11. Marisa Bisram. 2017. Modeling the enclosure environment on a 3-axis mill using coolant mist. Sponsored by Depuy Synthes. (Honors Degree Requirement).
12. Shannon Russell. 2017. Semi-automated extrusion loader for reagent vessels. Sponsored by Siemens Healthcare Diagnostics.
13. Connor Bydlon. 2016. Hopper transfer process for extruded plastic cuvette holders. Sponsored by Siemens Healthcare Diagnostics. (Honors Degree Requirement).
14. Steven Davis and Adam Smith. 2016. Test system for qualifying silicon lids on reagent delivery trays. Sponsored by Siemens Healthcare Diagnostics.
15. Michael Junken. 2015. Optimized design for the next generation plate lifting system for composite sample manufacturing. Sponsored by GE Aviation.
16. Hunter Bachman. 2015. Preventative maintenance statistical analysis for a tube manufacturing process. Sponsored by Superior Tube. Collegeville, PA (Honors Degree Requirement).
17. Rebecca Runkle. 2014. Automation of composite preforms into an autoclave for curing. Sponsored by GE Aviation, Newark, DE. (Honors Degree Requirement).
18. Michael McClintock. 2014. Integration of load measurement pins into the rear door of a round baler. (Honors Degree Requirement).
19. Derrick Herr. 2013. Modeling and testing of a robotically inserted surgical needle. Sponsored by Dr. Peter Popper.
20. Adrian Sawyer. 2013. Automation of honeycomb structure curing during manufacturing. Sponsored by Alcore, Edgewood, MD. (Honors Degree Requirement).
21. David Chun and Devon Prate. 2012. Development of a manufacturing process for composite honeycomb structures for aerospace applications. Sponsored by Alcore, Edgewood, MD.
22. David Eisensmith. 2012. Improved welding method for precision wound temperature sensors for aircraft applications. Sponsored by Sensing Devices, Inc.
23. Chanel Aldrich. 2012. Modeling and testing for a composite cap for impact tools. Sponsored by Hard Cap, LLC.
24. Michael Yeager. 2011. Forming process for composite plate manufacturing. Sponsored by the The Dupont Co. (Honors Degree Requirement).
25. Eric Wurtzel. 2011. Laminated aluminum expandable structures. Sponsored by Alcore, Edgewood, MD. (Honors Degree Requirement).
26. Daniel Russach. 2010. Failure modes analysis of a blood analysis machine using FMEA and Fault Tree techniques. Sponsored by Siemens Healthcare Diagnostics.
27. John Zerhusen. 2010. Implementation and validation of a non-contact torque test for a blood pump assembly process. Sponsored by Terumo Cardiovascular. 33
28. Connie Helstosky. 2010. Photovoltaic system sizing for a solar powered facility for the University of Delaware Creamery.
29. Kristen Saksa. 2010. Computer-Aided drafting methods for the University of Delaware Botanical Gardens. (1 credit).

30. Jennifer Iskai. 2009. Design of an automatic adhesive application process to attach an acrylic impeller to a pump motor shaft for the artificial heart-lung oxygenator. Sponsored by Terumo Cardiovascular.
31. Christopher Uthgenannt. 2009. Measurement of airflow characteristics of various disc mower design configurations. Sponsored by Case-New Holland. (6 credits)
32. Ronit Lilu. 2008. Implementation plan for lean manufacturing of an artificial heart-lung oxygenator. Sponsored by Terumo Cardiovascular.
33. Kasey Gust. 2008. Integration of an automated pressure regulator setting system for oxygen bottle manufacturing. Sponsored by Siemens Corp.
34. Daniel Brisach. 2008-09. Development of PWM charging strategies for ultracapacitors used on mobile equipment for energy storage. Sponsored by Case New Holland.
35. Mark Steimer. 2008. Control circuit simulation and prototyping of vehicle energy storage systems using ultracapacitors. Sponsored by Case New Holland
36. Michael Brill. 2008. Design and prototyping of a novel sanitary fly swatter (US Patent No. 6,957,510). Sponsored by Laura Simon, Esquire, Wilmington, DE.
37. Sean Collins and Doug Ericson. 2008. Modeling and experimental validation of an on-board hydraulic bale weighing system for round balers. Sponsored by Case New Holland. (3 credits for each student)
38. Dan Pron. 2007. Confined compression characteristics of a mineral reinforced polymer. Sponsored by Hard Cap, LLC.
39. Daniel Gempeshaw. 2007. Kinematic analysis of a composite marine seat structure for military applications. Sponsored by Revenge Composites (in fulfillment of his Honors Capstone Requirement).
40. Tom Coombes. 2007. Design and development of a hand-crank dynamometer as a hands-on museum activity. Sponsored by the Delaware Ag Museum. (4 credits)
41. Dan Pron. 2006-07. Testing of polymers for impact durability on a hammer face. Sponsored by Hard Cap, LLC.
42. Jesse Krisher. 2006. Development of an ALGOR finite element model for the prediction of femoral fractures from human falls. Sponsored by the DuPont Co.
43. Beth Miller, Erik Pearson, and James Woodhouse. 2006. Embedded controller development and vehicle testing of a drive-by-wire propulsion system for a windrower. Sponsored by CNH America, LLC. (3 credits each)
44. Matt Griffith. 2006. High strain rate testing of reinforced polymer inserts for power tools using a Split Hopkins Bar. Sponsored by Hard Cap, LLC.
45. John Armstrong and Greg Stewart. 2005. Design and testing of a mechanical harvesting system for indoor, closed system tilapia production. Sponsored by Blair View Aquaculture Farm. (3 credits each).
46. Julia Levinson. 2005. Automated measurement of laminate bond strength for substrates bonded to Teflon membranes. Sponsored by W.L. Gore and Associates.
47. Craig Livingston. 2005. Computer-aided-drafting fundamentals (1 credit).
48. Barry Levinson. 2005. Solid modeling with mechanical desktop (1 credit).
49. Mark Deaver. 2004-05. Parametric modeling and finite element analysis of disposable testing components for measuring laminate bond strength. Sponsored by W.L. Gore and Associates.
50. Gwen Thorsen. 2003-04. Software development and testing for the automatic transmission of data via a cellular modem. Sponsored by the Delaware Department of Natural Resources and Environmental Control. (6 credits)
51. Eric Busby. 2004. Development of a remote controlled drip tape cutter for drip tape laying equipment. Sponsored by Busby Farms.
52. Jennifer Lawrence and James Moore. 2004. Development of a test stand for the vibration analysis of power tools. Sponsored by Baltimore Tool Works, Inc. (3 credits each)
53. Dominic Schiavoni. 2004. Design of a drop tower for constant energy impact testing. Sponsored by Baltimore Tool Works, Inc.
54. Dan Muhlenforth. 2004. Design and testing of low vibration accessories for hand-struck tools. Sponsored by Baltimore Tool Works, Inc.
55. Derrick Dickerson. 2004. Development of an automated test device for evaluating the wear characteristics of poultry nipple drinkers. Sponsored by the Delaware Cooperative Extension Service. (co-advised w/ Gary Van Wicklen).
56. Eric Busby. 2004. Development and testing of a device for accelerated life testing of an *Air Pogo* toy. Sponsored by Leavis and Rests, P.C.
57. Dan Muhlenforth. 2003-04. Software and sensor arrangement for determining the frequency content of hand-mounted accelerometers. Sponsored by Baltimore Tool Works, Inc.
58. Dominic Schiavoni. 2003-04. Measurement of vibration transmitted to the hand from hand-struck and power tools. Sponsored by Baltimore Tool Works, Inc.

59. Dominic Pellegrenio. 2003. Design of a steel frame flooring system with EPS foam insulation. Sponsored by Ecothermal Panel Systems, Inc.
60. Mike Fyock and Dan Meckley. 2003. Structural analysis and hydraulic automation of a prototype kicker for round balers. Sponsored by Case New Holland, Inc. (3 credits each)
61. Annie Tseng. 2003. An automated testing machine and methodology for ceramic wafer substrates used for blood sample analysis. Sponsored by Dade Behring.
62. Matt Mitch. 2002. Development of a computer design tool for the cooling systems on skid-loaders. Sponsored by Case-New Holland, Inc.
63. Dawn Cintavey. 2002. Finite element analysis of extruded aluminum structures. Sponsored by National Forensics Engineers, Inc.
64. Mark Orgovan and Dan O'Brien. 2002. Evaluation of a two-piece chisel system designed with a high performance engineering polymer impact surface. Sponsored by Baltimore Tool Works, Inc. (3 credits each)
65. Pete Truitt. 2002. Automated pneumatic capping system for dental adhesive capsules. Sponsored by Densply-Caulk.
66. Julian Jones and Matt Dougherty. 2002. Development of an automated cutter for plastic sleeves. Sponsored by Xymid, LLC.
67. Tony Nasr. 2002. Design and Instron testing of a framing system and fasteners for electrically insulated attachment of solar panel systems to steel-framed structures. Sponsored by the UD Solar Decathlon and AstroPower.
68. Tony Nasr. 2002-03. Ergonomic testing trials of a new low vibration, hand-struck chisel system. Sponsored by Baltimore Tool Works, Inc.
69. Mike Vassallo. 2002. Development of high volume compression system for preparing inoculated silage samples. Sponsored and co-advised by Dr. L. Kung.
70. Rich Herseim. 2002. Design, analysis and testing of plastic drivetrain shields on Case-New Holland windrower headers. Sponsored by Case-New Holland, Inc.
71. Pete Truitt. 2002. Finite element analysis of the impact of a hammer-tool system. Sponsored by Baltimore Tool Works, Inc.
72. Andrew Drysdale. 2002. The current state of photovoltaic technology. (as part of his Honors Degree Capstone Requirement in Mechanical Engineering).
73. Doug Cook, Jeff Gordon, and Matt Dunson. 2001. Development of *AutoGap*: a control system for the automatic adjustment of windrower roll gap. Sponsored by Case New Holland, Inc. (3 credits each)
74. Ian Cosden. 2001. Control software development and field testing for the closed loop control of DC motor angular displacement for mower-conditioner roll gap adjustment. Sponsored by Case-New Holland, Inc.
75. Tim Filasky. 2001-02. Design of a precision push planter. Sponsored by Delaware Cooperative Extension and Rogers Seed Co.
76. Mac Cushing. 2001-03. Design of an automatic fabric feed system for a numerically controlled laser cutter. Sponsored by Cirrus Engineering.
77. Nikki Rossi. 2001. Feasibility of an on-line degradation sensor for soy-based hydraulic fluids. Part of a project funded by DuPont. (co-advised with Mike Keefe)
78. Chad Stover. 2000. Development of improved vaccination system for day-of-age Marak's vaccine. Sponsored by the Allen Laboratory, University of Delaware.
79. Andy Park. 2000. Development of learning modules for CAD/CAM and CNC machining for undergraduate design courses. (co-advised with Dr. Michael Keefe).
80. Matt Dunson and Yuen Yoong Leong. 2000. Demeter project system ID and PID controller design. Sponsored by New Holland, N.A.
81. Matt Behr. 1999. Development of a non-invasive sensing method for the measurement of watermelon sugar content. Sponsored by University of Delaware Cooperative Extension.
82. Ken Miller and Rob Banks. 1998. Experimental evaluation of a subcutaneous vaccination system for day-of-age Marek's vaccine. (co-advised with Dr. Michael Keefe).
83. John Filasky. 1997. Design requirements for a watermelon harvester. Sponsored by University of Delaware Cooperative Extension.
84. Dan Hoffstetter. 1997. Yield monitor designs for vegetable harvesters. Sponsored as part of a grant from FMC Corporation.

SCHOLARSHIP

BOOK CHAPTERS

1. S. Zhengjie Jia, J. Gunasekera, and J.L. Glancey. 2023,. Chapter 11: Computer integrated sustainable manufacturing. Sustainable Manufacturing Processes. Published Academic Press, Elsevier, Inc.
2. Glancey, J.L. 2011. Vacuum-Based Resin Transfer Molding Techniques for Manufacturing Composite Materials and Components. *Innovations in Materials and Manufacturing Methods*. Abingdon, Oxford, UK.
3. Glancey, J.L. 2003. Machine Design for Vegetable Production Systems, Chapter from *The Encyclopedia of Agricultural, Food and Biological Engineering*, Marcel Dekker, New York, NY.

REFEREED PUBLICATIONS

Journal Articles

1. Alms, J.B., J.L. Glancey, and S.G. Advani. 2011. Liquid composite molding control methodologies using vacuum induced preform relaxation. Composites, Part A. 42(1): 57-65.
2. Cheng, L., A. Thomas, J. L. Glancey, and A.M. Karlsson. 2011. Mechanical behavior of bio-inspired laminated composites. Composites, Part A. 42(2): 211-220.
3. Alms, J.B., J.L. Glancey, and S.G. Advani. 2010. Mechanical properties of composite structures fabricated with the vacuum induced preform relaxation process. Composite Structures 92: 2811–2816.
4. Alms, J.B., L. Garnier, J.L. Glancey, and S.G. Advani. 2010. In-plane permeability characterization of the vacuum infusion processes with fiber relaxation. International Journal of Material Forming 3(2): 1267-1275.
5. Wang, J., J.L. Glancey and J.R. Vinson. 2009. The effects of in-plane shear loads on transverse shear deformations in laminated and sandwich composite panels. Journal of Aircraft, 46(5): 1473-1478.
6. Alms, J.B., A. Catry, J.L. Glancey and S.G. Advani. 2009. Flow modification process for vacuum infusion using port-based resin flow control. SAMPE Journal, 45(2): 54-63.
7. Glancey, J.L., J.T. Sims, and D. Snyder. 2008. Field evaluation of a mechanical topdresser for solid wastes. Biosystems Engineering, 99(3): 432-443.
8. Glancey, J.L., J. Hummel, A. Chirnside, S. Nobles, S. Chanpimol and A. Ravel. 2007. Bio-fuel emission measurements and potential environmental implications for the Mid-Atlantic Region. Journal of Environmental Monitoring and Restoration, 3: 158-166.
9. Keefe, M., J. Glancey, and N. Cloud. 2007. Assessing student team performance in industry-sponsored design projects. Transactions of the ASME, Journal of Mechanical Design, 129(7): 692-700.
10. Brown, D., and J.L. Glancey. 2007. Theoretical and experimental analysis of a continuous blade cutter for leafy vegetables. Transactions of the ASABE, 50(3): 803-813.
11. Nalla, A., M. Fuqua, J.L. Glancey and B. Leleiver. 2007. A multi-segment injection line and real-time adaptive, model-based controller for vacuum assisted resin transfer molding. Composites, Part A: Applied Science and Manufacturing, 38: 1058–1069.
12. Glancey, J., J.T. Sims and D. Snyder. 2007. Agronomic and environmental implications of sidedressed poultry manure as a nitrogen source for crops. Journal of Environmental Monitoring and Restoration, 3: 206-221.
13. Krishnan, M., R. Strosser, J.L. Glancey, and J.Q. Sun. 2006. Adaptive modeling and control of a precision manure spreader. Computers and Electronics in Agriculture, 52(1-2):1-10.
14. Glancey, J.L., W.E. Kee, T.L. Wootten and M. Dukes. 2005. A mechanical harvesting index for horticultural crops. Applied Engineering in Agriculture, 21(4): 555-558.
15. Glancey, J.L., and W.E. Kee. 2005. Engineering aspects of production and mechanization for fresh and processed vegetables. HortTech, 15(1): 76-79.
16. Glancey, J.L., W.E. Kee, and T.L. Wootten. 2005. Technical and strategic advances in vegetable mechanization. HortTech, 15(3): 486-488.
17. Glancey, J.L., R. Strosser, I. Cosden, J. Gordon, M. Dunson, and D. Cook. 2005. A system for the automatic adjustment and control of conditioning roll gap on mower conditioners. SAE Transactions, Journal of Commercial Vehicles, 113(2): 645-650.
18. Wang, J., J.R. Vinson., and J.L. Glancey. 2004. Geometric nonlinear deformation effects in composite sandwich plates subject to in-plane shear loads. Journal of Sandwich Structures and Materials, 6(5): 447-457.
19. Birmingham, A., E. Buzby, D. Davis, E. Benson, J. Glancey, W. Pill, T. Evans, R. Mulrooney, and M. Olszewski. 2004. A precision planter for large seeds in small plots. HortTech, 14(4): 574-576.
20. Keefe, M., J.L. Glancey, and Z. Zhong. 2000. Performance of high oleic soybean oil-based hydraulic fluids in long-duration pump tests. Society of Automotive Engineers Special Publication SP-136, Lubricants for Off-Highway Vehicles.

21. Glancey, J.L., S. Knowlton, E.R. Benson. 1999. Development of a high oleic soybean oil-based hydraulic fluid. SAE Transactions, 107(2): 266-269.
22. Sankula, S., M.J. VanGessel, W.E. Kee and J.L. Glancey. 1999. Impact of row spacing and herbicide rate and application method on weed control and harvest efficiency of lima beans. HortTech, 9(4): 633-637.
23. Kung, L. Jr., A.C. Sheperd, A.M. Smagala, K.M. Endres, C.A. Bessett, N.K. Ranjit, and J.L. Glancey. 1998. The effect of preservatives based on propionic acid on the fermentation and aerobic stability of corn silage and a total mixed ration. Journal of Dairy Science, 81(5): 1322-1330.
24. Glancey, J.L., W.E. Kee, and T.L. Wootten. 1997. Machine harvesting of lima beans for processing. Journal of Vegetable Crop Production. 3: 59–68.
25. Kee, W.E., J.L. Glancey, and T.L. Wootten. 1997. The lima bean: A vegetable crop for processing. HortTech 7(2): 119-128.
26. Glancey, J.L. 1997. Analysis of header loss from pod stripper combines in green peas. Journal of Agriculture Engineering Research. 68: 1-10.

Peer Reviewed Proceedings

1. Brisach, D., J. Alms, J. Glancey and N. Cloud. 2009. Integrated cut performance and sample inspection system for microtome setup evaluation. DETC2009-87570. DETC2009-87521. Proceedings of the ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, California.
2. Brisach, D., M. Griffith, J. Konchar, S. Petfield, P. Popper, and J.L. Glancey. 2007. Attenuation of impact and continuous vibration in the hand and arm. The ASME International Design Engineering Technical Conferences: The 21st Biennial Conference on Mechanical Vibration and Noise, & Applications of Vibration and Acoustics in Biomedical Engineering, Las Vegas, NV.
3. Griffith, M., D. Brisach, J. Konchar, S. Petfield, P. Popper, and J.L. Glancey. 2007. Polymer-based vibration and noise emission control characteristics for hand-struck tools. Proceedings of the ASME International Design Engineering Technical Conferences: The 19th Reliability, Stress Analysis and Failure Prevention Conference, Las Vegas, NV.
4. Kasprzak, S., M. Fuqua, J. Nasr, and J.L. Glancey. 2006. A robotic system for real-time resin flow modification during vacuum-assisted resin transfer molding of composite materials. Proceedings of the 2006 ASME International Annual Meeting, Chicago, IL. IMECE2006-14416.
5. Fuqua, M. and J.L. Glancey. 2006. A port injection process and control for improved resin delivery and flow. Proceedings of the 2006 ASME International Annual Meeting, Chicago, IL. IMECE2006-14422.
6. Konchar, J., P. M. Griffith, P. Popper, and J.L. Glancey. 2006. Modeling and testing of a new polymer-based impact tool design to reduce biomechanical injuries. Proceedings of the 2006 ASME International Annual Meeting, Chicago, IL. IMECE2006-14416.
7. Nalla, A. and J.L. Glancey. 2005. Closed loop control of resin flow in VARTM using a multi-segment injection line and real-time adaptive, model-based control. Paper No. IMECE2005-81767. Proceedings of the 2005 ASME International Annual Meeting, Orlando, FL
8. Glancey, J.L., R. Strosser, I. Cosden, J. Gordon, M. Dunson, and D. Cook. 2004. A system for the automatic adjustment and control of conditioning roll gap on mower conditioners. SAE Technical Paper Number 2004-01-2732 and SAE Special Publication No. SP 1914.
9. Vinson, J., J.L. Glancey and G.A. Snyder. 2004. Analysis, design and optimization of high performance sandwich water skis, the ASME-IMECE, Long Beach, CA. November 2004.
10. Glancey, J.L., G.A. Snyder (National Forensic Engineers, Inc.), and J.R. Vinson. 2003. Experimental evaluation of the structural characteristics of extruded aluminum stepladders. Proceedings of the ASME International Design Engineering Technical Conferences: The 17th Reliability, Stress Analysis and Failure Prevention Conference, Chicago, Illinois.
11. Snyder, G.A. (National Forensic Engineers, Inc.), J.L. Glancey, and J.R. Vinson. 2003. Failure analysis of stepladders manufactured from extruded aluminum. Paper No. IMECE2003-41526. Proceedings of the 2003 ASME International Annual Meeting, Washington, D.C.
12. Glancey, J.L., P. Popper (DuPont), M. Mitch, P. Truitt, T. Nasr, M. Orgovan, J. Stevens. 2003. A new cyclic impact device and standard testing methodology for hand struck tools. Paper No. IMECE2003-41451. Proceedings of the 2003 ASME International Annual Meeting, Washington, D.C.
13. Glancey, J.L., P. Popper (DuPont), T. Nasr, P. Truitt, M. Orgovan, D. O'Brian. 2003. Design and performance of hand-struck impact tools using high performance polymers. Paper No. IMECE2003-41455. Proceedings of the 2003 ASME International Annual Meeting, Washington, D.C.

14. Wang, J., J.L. Glancey, and J.R. Vinson. 2002. Transverse shear deformation effects in laminated and sandwich composite panels subjected to in-plane shear. Proceedings of the ASME IMECE, New Orleans, LA.

PEER-REVIEWED PUBLISHED ABSTRACTS

1. Glancey, J.L. 2009. Mechanical harvesting of several small greens. HortScience, 44(3): 545-554.
2. Brown, D. and J.L. Glancey. 2007. Mechanical harvesting of spinach. HortScience, 42(3): 429-434.
3. Glancey, J.L. 2007. Yield, plant architecture, and machine harvest characteristics of several leafy greens grown for processing. HortScience, 42(3): 429-434.
4. Glancey, J.L. 2003. Recent advances in machine harvest of fruits and vegetable: Engineering aspects of production and mechanization for fresh and processed vegetables. HortScience, 38(5): 800.
5. Glancey, J.L. and W.E. Kee. 2003. The U.S. Vegetable Industry Past and Future: Technical and Strategic Advances in Mechanization. HortScience, 38(5): 830.

NON-REFEREED RESEARCH PAPERS & PROCEEDINGS

1. Armstrong, J., G. Stewart, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester, and J. Glancey. 2010. Applying engineering and ergonomic principles to the aquaculture industry. Proceedings of the 2010 National Agrability Annual Workshop. Charleston, WV.
2. Alms, J., J. Glancey and S. Advani. 2009. Mechanical properties of composite structures made with the vacuum induced preform relaxation process. Proceedings of the American Society for Composites, Twenty-fourth Technical Conference. Newark, DE.
3. Ciappi, R., B. Miller, S. Petfield, C. Uthgenannt, J. Glancey, K. Smith and M. Harkcom. 2009. Design of a protective curtain system for high rotational speed disc mowers. DETC2009-87570. Proceedings of the ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, California.
4. Alms, J., J. Glancey and S. Advani. 2009. Development of computer controlled flow manipulation for vacuum infusion processes. Proceedings of ICCM-17, the International Committee on Composite Materials, Edinburgh, Scotland.
5. Alms, J., J. Glancey and S. Advani. 2009. Sequential injection using a gantry positioning system for flow control in vacuum resin infusion processes. Proceedings of the 2009 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
6. Alms, J., J. Glancey and S. Advani. 2008. Experimental determination of permeability of woven fiber glass during the vacuum induced preform relaxation (VIPR) process. Proceedings of the 9th International Conference on Textile Composites (TEXCOMP9). Newark, DE.
7. Alms, J., J. Glancey and S. Advani. 2008. Experimental validation of a port based injection methodology for vacuum infusion processes. The 2008 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Long Beach, CA.
8. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9), July 7th to 9th, Montreal, Quebec, Canada.
9. Collins, S., D. Erickson, S. Mabel, D. Shannon, K. Smith and J. Glancey. 2008. Design and prototyping of a hydraulic hose and cable organizer for mobile equipment. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
10. Dibelka, J., M. Steimer, L. Traub, J. Twomey, J. Glancey, S. Woods, and S. Phillips. 2008. Design of a heat removal method for the electronics in lithium-ion cordless power tools. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
11. Glancey, J. 2008. Mechanical harvesting characteristics of several leafy greens grown for processing. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
12. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. Proceedings of the American Society for Composites, Twenty-third Technical Conference. Memphis, TN.
13. Pearson, E. J. Woodhouse, B. Miller, R. Strosser and J. Glancey. 2008. Performance of a prototype steer-by-wire driving system for self-propelled windrowers. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.

14. Stewart, S., J. Armstrong, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester and J. Glancey. 2008. Mechanical harvesting system for improving the ergonomics for in-door, closed system, live market tilapia production. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
15. Collins, S., D. Erickson, S. Mabel, D. Shannon, K. Smith and J. Glancey. 2008. A hydraulic hose and electrical cable organizer and support for agricultural implements. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
16. Glancey. J. 2008. Feasibility of on-site cucumber relish manufacturing from mechanically harvested culled fruit: mechanical and energy requirements. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
17. Fuqua, M. and J. Glancey. 2008. Resin position sensing and control during infusion of composite panels as a cost-effective alternative to metal shielding and panels on agricultural and construction equipment. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
18. Glancey, J., R. Gorlich, and R. Jester. 2008. Mechanically-assisted composting of fish mortalities for disabled aquaculture producers. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
19. Glancey, J., J. Vinson and D. Brisach. 2008. Side rail flexibility and the potential for spreader bar failures on tall step ladders. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
20. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9), July 7th to 9th, Montreal, Quebec, Canada.
21. Glancey, J, D. Hoffstetter, and E. Kee. 2008. Impact characteristics of pickling cucumber and their potential effect on mass flow rate measurement. Application of Precision Agriculture for Fruits and Vegetables, January 6th – 9th, 2008, Orlando, FL.
22. Alms, J., J. Lawrence, A. Catry, J. Glancey and S. Advani. 2007. Resin delivery and control workstation for VARTM. Proceedings of the Sixth Canadian-International Composites Conference, Winnipeg, Manitoba, Canada.
23. Konchar, J., D. Brisach, M. Griffith, J. Nasr, P. Popper, and J. Glancey. 2007. Design and testing of composite driveline components for impact tools. Proceedings of the 2007 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
24. Kasprzak, S., J. Nasr, M. Fuqua, and J. Glancey. 2007. An external flow modification system for vacuum-assisted resin transfer molding. Proceedings of the 2007 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
25. Fuqua, M. and J.L. Glancey. 2007. The effects of in-tool resin delivery ports on process control and molded part quality for vacuum-based composite manufacturing. Proceedings of the Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
26. Nasr, J., M. Fuqua, S. Kasprzak, and J. Glancey. 2007. Modeling and experimental validation of an external flooding chamber for vacuum-based composite molding. Proceedings of the Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
27. Brisach, D., M. Griffith, S. Petfield, P. Popper, and J. Glancey. 2007. Evaluation of reinforced polymer composites for engineering controls of sound and vibration. Proceedings of the Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
28. Alms, J., S. Advani, and J. Glancey. 2007. Vacuum induced preform relaxation (VIPR) method for liquid composite molding (LCM) processes. Proceedings of the Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
29. Fuqua, M., and J. Glancey. 2007. Design and performance of a closed loop control, port-based resin delivery system for vacuum-assisted resin transfer molding. The 2007 Society for the Advancement of materials and process engineering symposium and exposition, Baltimore, MD. v52.
30. Glancey, J.L., J. Hummel, S. Nobles, S. Chanpimol. 2007. Measurement of transient smoke emissions characteristics from e-diesel and soy-diesel fuel blends in two commercial engines. Proceedings of the 2007 ASABE International Annual Meeting, Minneapolis, MN.
31. Glancey, J.L. 2007. Once-over harvesting of several leafy greens. 2007. Proceedings of the 2007 ASABE International Annual Meeting, Minneapolis, MN.
32. Brisach, D., M. Griffith, P. Popper and J. Glancey. 2007. Measurement of vibration transmission in the hand and arm from impact and continuous vibrating sources. Proceedings of the 2007 ASABE International Annual Meeting, Minneapolis, MN.
33. Glancey, J., Konchar, D. Brisach, and P. Popper. 2006. Reducing vibration-related injuries from hand and power tools. Proceedings of the 2006 National Ergonomics Conference and Exposition. Las Vegas, NV.

34. Armstrong, J., G. Stewart, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester, and J. Glancey. 2006. Improving the ergonomics of harvest for in-door, closed system, live market tilapia production. ASABE Paper No. 065003. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
35. Griffith, M., J. Nasr, P. Popper, and J.L. Glancey. 2006. A reinforced polymer hammer cap for eliminating metal-to-metal contact and reducing hand-transmitted vibration. ASABE Paper No. 061139. ASABE, 2959 Niles Road, St. Joseph, MI 49085-9659.
36. Fuqua, M. and J.L. Glancey. 2006. Development of a port injection process for vacuum-assisted resin transfer molding. Proceedings of the 2006 Society for the Advancement of Materials and Processes, Long Beach, CA.
37. Glancey, J., J. Konchar, and P. Popper. 2006. Measuring the potential for noise and vibration injuries in industrial settings. Proceedings of the 2006 Eastern Ergonomics Conference and Exposition. Boston, MA.
38. Fuqua, M. and J.L. Glancey. 2006. Modeling of vacuum-assisted resin transfer with in-mold ports. Proceedings of the Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
39. Nasr, J., S. Kasprzak, and J. Glancey. 2006. External modification of VARTM flow with a rigid external chamber. Proceedings of the Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
40. Kasprzak, S., M. Fuqua, J. Nasr, and J.L. Glancey. 2006. A real-time resin flow modification robot for vacuum-assisted resin transfer molding of composite materials. Proceedings of the Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
41. Nalla, A. and J. Glancey. 2006. Adaptive, model-based control for resin transfer molding. Proceedings of the Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
42. Brown, D., and J.L. Glancey. 2006. Stability analysis and testing of a continuous blade band-type cutter for leafy vegetables. ASABE Paper No. 061139. ASABE, 2959 Niles Road, St. Joseph, MI 49085-9659.
43. Glancey, J.L. 2005. Design and performance of a hydro-unloading system for machine harvested vegetables. ASAE Paper No. 051080. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
44. Glancey, J.L., G. Snyder, J. Vinson, J. Krisher, and P. Franklin. 2005. Fiberglass and aluminum stepladder performance under dynamic loading conditions. Proceedings of the 2006 ASABE International Annual Meeting, ASABE Paper No. 055009. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
45. Glancey, J.L., P. Popper, and J. Konchar. 2005. Ergonomic benefits of polymer capped chisels. ASAE Paper No. 055012. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
46. Konchar, J. P. Popper and J. Glancey. 2005. Workshop on hand-arm vibration and noise: Overview of current limits and strategies for reducing working exposure and injury. Proceedings of the 2005 Eastern Ergonomics Conference and Exposition, New York, NY.
47. Glancey, J.L., K. Carlisle, and W. Carlisle. 2005. High speed mechanical harvesting of spinach. NABEC Paper No. 05027. 2005 NABEC Annual Conference, Lewes, DE.
48. Kasprzak, S., M. Fuqua, M. Griffith, J. and J. L. Glancey. 2005. An overview of composite manufacturing processes and applications. NABEC Paper No. 05028. 2005 NABEC Annual Conference, Lewes, DE.
49. Brown, D., D. Jones, and J.L. Glancey. 2005. Measurement of embryo temperature in incubating avian eggs. NABEC Paper No. 05P008. 2005 NABEC Conference, Lewes, DE.
50. Sims, J.T., J.L. Glancey, and D. Snyder. 2005. Field evaluation of an applicator for sidedressing row crops with solid wastes. NABEC Paper No. 05P006. 2005 NABEC Conference, Lewes, DE.
51. Konchar, J., J. Glancey, P. Popper. 2005. Sound emission characteristics of new hand-struck tools designed with high performance engineering polymers. NABEC Paper No. 05P007. 2005 NABEC Conference, Lewes, DE.
52. Glancey, J.L., G. Snyder, J. Vinson, J. Krishnan, P. Franklin. Dynamic loading of fiberglass step ladders. NABEC Paper No. Paper No. 05P005. 2005 NABEC Conference, Lewes, DE.
53. Glancey, J.L., R. Strosser, I. Cosden, M. Dunson, J. Gordon, and D. Cook. 2005. Automatic adjustment and control of the conditioning roll gap on mower-conditioners. NABEC Paper No. 05P011. 2005 NABEC Conference, Lewes, DE.
54. Smith, K., G. Thorson, J.L. Glancey, and S. Huerta. 2005. Real-time surveillance of shallow depth estuaries for water quality and harmful algal blooms. ASCE Paper Number: 40763-7510. 2005 ASCE Watershed Management Conference, Williamsburg, VA.
55. Herseim, R., J.L. Glancey, P. Popper, W. Walker, K. Ranjan, and J. Tretacosta (DuPont, Co.). 2004. Simulation of the mechanics of human falls. ASAE Paper 047026. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.

56. Glancey, J.L., P. Popper, J. Moore, D. Muhlenforth, and T. Nasr. 2004. Modeling and experimental evaluation of hand and power tools vibration transmission to the hand and arm. ASAE Paper 047027. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
57. Smith, K. and J. L. Glancey. 2004. Design and testing of a low-cost whole water column, near real-time surveillance device for shallow depth estuaries. ASAE Paper 042257. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
58. Glancey, J.L., W.E. Kee, and T.L. Wootten. 2004. Effects of plant architecture on the mechanical recovery of bush-type vegetable crops ASAE Paper 041024. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
59. Herseim, R., J. Moore, and J. L. Glancey. 2004. An instrumented device for measuring the dynamics of human falls. Paper No. 04-0050. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
60. Smith, K., G. Thorson, and J. L. Glancey. 2004. Progress in developing low cost, near-real-time surveillance systems for water quality monitoring in Delaware. Paper No. 04-0051. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
61. Nalla, A., B. Leleiver, and J.L. Glancey. 2004. Performance of a new VARTM resin injection line. Proceedings of the 7th International Conference on Flow Processes in Composite Materials, Newark, Delaware.
62. Nalla, A., J.L. Glancey and B. Leleiver. 2004. Theoretical and experimental evaluation of a segmented injection line for resin flow control in VARTM. Proceedings of the 7th International Conference on Flow Processes in Composite Materials, Newark, Delaware.
63. Wang , J., J.R. Vinson., and J.L. Glancey. 2002. Geometric nonlinear deformation effects in composite sandwich plates subject to in-plane shear loads. Proceedings of the 10th US-Japan Conference on Composite Materials, Stanford University, Stanford, CA.
64. Glancey, J. L. 2001. Digital signal processing of the storage bin mass on mobile equipment for the prediction of crop mass flow rate and yield. ASAE Paper No. 01-1102. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
65. Glancey, J.L., J.K. Rosenberger, and S.S. Cloud. 1999. Measurement of embryo and air cell temperatures in incubating broiler eggs. Abstract #9938. The 10th Annual Northeast Agricultural and Biological Engineering Conference, Lancaster, PA.
66. Knowlton, S (Dupont), and J.L. Glancey. 1998. Development of a high oleic soybean oil-based hydraulic fluid. 1998. Proceedings of the 89th Annual Meeting of the American Oil Chemists Society. Chicago, IL, May 1998.
67. Glancey, J.L., D.W. Hofstetter, W.E. Kee and T.L. Wootten. 1998. Yield and soil property variations in processed vegetable production on the Delmarva Peninsula. ASAE Paper #981099. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
68. Glancey, J.L., W.E. Kee, T.L. Wootten and D.W. Hofstetter. 1998. Feasibility of once-over mechanical harvest of processing squash. ASAE Paper #981093. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
69. Glancey, J.L., D. Hoffstetter, W.E. Kee, T.L. Wootten, and M. Lynch. 1997. Preliminary evaluation of yield monitoring techniques for vegetables. ASAE Paper # 971060. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
70. Glancey, J.L., S. Seymour, C. Bohman, R. Sheehan, and J. Posselius (New Holland N. A., Inc.) 1997. Development of a precision industrial spreader for the land application of solid wastes. ASAE Paper # 971081. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
71. Glancey, J.L., W.E. Kee, and T.L. Wootten. 1997. Reducing damage and improving recovery of mechanically harvested pickling cucumbers. ASAE Paper #971017. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.
72. Glancey, J.L., W.E. Kee, T.L. Wootten. 1997. Modeling recovery of pod stripper combines used for the mechanical harvesting of processed vegetables. Proceedings of the 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
73. Kee, W.E., T.L. Wootten and J.L. Glancey. 1997. Production systems to optimize mechanical harvest of pickling cucumbers. Proceedings of the 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
74. Glancey, J.L. 1997. Yield monitoring of lima beans in pod stripper combines. Proceedings of the Biennial Meeting of the Bean Improvement Cooperative, Annapolis, MD.
75. Glancey, J.L. 1997. Yield monitoring of peas with pod stripper combines. Proceedings of the Biennial Meeting of the Pea Improvement Cooperative, Annapolis, MD.

NON-REFEREED TEACHING PAPERS

1. Glancey, J.L. 2006. Faculty and industry partnerships through sponsored research and design projects targeted to enhance undergraduate education. ASABE Paper No. 068022. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.

2. Keefe, M., J.L. Glancey, and N. Cloud. 2005. A case study in assessing team-based design courses that integrate industry-sponsored projects. Paper No. IMECE2005-81756. Proceedings of the 2005 International Mechanical Engineering Congress and Exposition, Orlando, FL

ARTICLES IN THE POPULAR PRESS ABOUT RESEARCH & OUTREACH

1. *USA Today.* Study: Water pollution from poultry farms overestimated. 2013.
2. *The News Journal*. Poultry pollution has been overestimated, UD-led study finds. 2013
3. *The Public Trust Project.* Fowling the Bay?: Media Reports Absolving Poultry Industry of Pollution are Premature. 2013.
4. *NASDA*. Study Shows EPA Overestimates Poultry Pollution in Chesapeake Bay. 2013
5. *The New York Times*. A Long Journey to a Kinder Chisel. February, 2008.
6. *Consumer Reports Magazine*. Exercise and Fitness- Panelists don't see benefit in Soloflex device. July, 2007.
7. *Woodwords on the Brandywine*. Meeting Highlights – New Tool Demonstrations. April, 2007.
8. *Consumer Reports Magazine*. Ladders – some can extend your risk. September, 2006.
9. *DuPont News.* DuPont™ Zytel® Nylon Helps Rejuvenate Hardworking Tool. October, 2006.
10. *The News Journal*. Disabled farmers overcome obstacles. July, 2006
11. *The Vegetable Growers News*. High-tech thumper. Watermelon sensor may put an end to ripeness guessing game. July 1999.
12. *Entrepreneur*. Watermelon ripeness sensor promises savings worldwide. July, 1999.
13. *ScienceDaily*. Watermelon Ripeness Sensor Might Promise Huge Savings For Growers Worldwide. June, 1999.
14. *Newswise*. Watermelon Ripeness Sensor, Savings for Growers. June, 1999.
15. *Lubricants World*. Development of a high oleic soybean oil-based hydraulic fluid. January, 1999.
16. *Lubes-N-Greases*. Let's Get Small. February, 1997

INVITED PRESENTATIONS

1. Adapting wastewater irrigation for the new Artesian treatment facility in Milton, DE. 2020. Internal meeting at Artesian Water Co., Lewes, DE
2. Equipment handling and mechanical safety for agricultural operations. 2017. The First Annual Delaware Farm Bureau Safety Conference. Harrington, DE
3. Recommended regulatory changes for the Delaware spray-on-demand wastewater distribution program. 2017. Joint meeting of the DNREC and DDA Cabinet Secretaries. (w/ Mayor Ken Branner, Middletown and Scott Hoffman, Duffield Associates). Dover, DE.
4. Changes to the EPA Chesapeake Bay Model inputs for poultry litter nitrogen and phosphorous generation in the bay watershed. 2017. Chesapeake College, Wye, MD.
5. Wastewater treatment and disposal options for small villages and communities. 2016. Joint meeting of the State of Delaware Delegation and the Government of Rengo. Rengo, Chile.
6. Using team-based design projects to build university and industrial partnerships. 2016. Joint meeting of the State of Delaware Delegation and the University of O'Higgins faculty and administration. Rengo, Chile.
7. Reusing treated wastewater for the irrigation of agricultural crops. 2016. Joint meeting of the State of Delaware Delegation and the Government of O'Higgins. Rancagua, Chile.
8. Electrocution and fire hazards outside the poultry house. 2016. Special Poultry Safety Seminar in Honor of Bill Brown. Georgetown, DE.
9. Prediction of NOx and PM emission reductions by converting industrial backup and load shaving generators to Tier 4 diesel engines. 2016. The Delaware Electric Cooperative. Greenwood, DE.
10. Production of N and P from poultry production as part of an overall production mass balance (given by Ed Kee). 2015. Wye Research Center, University of Maryland, MD
11. Updates on the Improved Poultry Data for Modeling the Chesapeake Bay Watershed. 2015. Monthly meeting of the Nutrient Management Commission. Dover, DE.
12. Predicting Poultry N and P generation based on improved estimates for litter concentrations, generation and bird populations. Perdue Agri-Business Orientation Meeting for New Executives. Dover, DE.
13. Comparison of Methods for Estimating Poutry Manure Nutrient Generation in the Chesapeake Bay Watershed. 2014. Meeting of the Northeast Secretaries of Agriculture. Boston, MA.
14. Land application of highly treated municipal wastewater for agricultural uses: Results of a three year pilot project. Scientific and Technical Advisory Committee. 2014. Center for the Inland Bays. University of Delaware, Lewes, DE.

15. Status and timeline for implementing changes to the Chesapeake Bay Watershed Model. EPA Region 3 Headquarters. 2014. Philadelphia, PA
16. The EPA and Chesapeake Bay Program modeling of the Chesapeake Bay Watershed - Deficiencies and Current Efforts to Improve Model Inputs. The International Poultry Production and Processing Expo. 2014. Atlanta, GA. (given by Kelley Shenk, EPA).
17. Status of revised data inputs to the Chesapeake Bay Watershed Model. Chesapeake Bay Regional Poultry Production Data Meeting. 2014. Beltsville, MD.
18. Final recommendations for the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program Ag Working Group. 2014. College Park, MD.
19. Proposed recommendations for the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program WQGIT. 2014. College Park, MD.
20. Recommendations to improve nitrogen and phosphorous loading from the poultry industry in the Phase 6 Chesapeake Bay Watershed Model. 2014. Center for the Inland Bays. University of Delaware, Lewes, DE.
21. Poultry Litter Subcommittee Update: Status & Updated Summary. Presentation to the EPA Region Ill and Chesapeake Bay Program upper administrations. 2013. Buena Vista, New Castle, DE.
22. Setup and operation of hay balers for optimal hay quality. Delaware Ag Week Technical Sessions. 2014 Harrington, DE.
23. Conditioning options to minimize hay drying time. The Maryland Southern Hay Production Meeting. 2014. Brandywine, MD
24. Updates regarding the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program Summit. 2013. College Park, MD.
25. Overview of the Chesapeake Bay Program Modeling of Delmarva – Concerns and current status. The Delaware and Maryland Congressional Delegation's Poultry Summit. 2012. Delmar, DE. (w/ Secretary Ed Kee and Senators Carper, Coons, Mikulski, Cardin)
26. Comparison of methods for estimating poultry manure nutrient generation in the Chesapeake Bay watershed. 2012. Quarterly meeting of the Chesapeake Bay Program Water Quality Goal Implementation Team. Annapolis, MD.
27. Comparison of University of Delaware and Delaware Department of Agriculture and Environmental Protection Agency Nitrogen and Phosphorous Estimation Methods within the Chesapeake Bay Watershed. Meeting of the Northeast Presidents of Farm Bureau. 2012. Boston MA.
28. Power purchase agreements for large scale industrial businesses. Annual meeting of the Delmarva Poultry Industry. 2012. Ocean City, MD.
29. The Chesapeake Bay Program modeling of the Bay watershed. Meeting of the Northeast Council of Governance. 2012. Atlantic City, NJ.
30. Technical and financial consideration for solar power purchase agreements. Solar work shop for the Delmarva Poultry Industry. 2011. Georgetown, DE.
31. Calculation of assimilation rates for nutrients and heavy metals for as-needed spray irrigation of agricultural crops with treated wastewater. 2011. Monthly meeting of the Bridgeville Town Council. Bridgeville, DE.
32. Updates regarding the Chesapeake Bay Program modeling of the Bay watershed. 2011. Meeting of the Delaware Nutrient Management Commission. Dover, DE.
33. Current estimates for N and P amounts on Delmarva. 2011. Joint meeting of the Delmarva Poultry Association's Environmental and Grower Committees. Salisbury, MD.
34. Comparison of University of Delaware and Delaware Department of Agriculture and Environmental Protection Agency Nitrogen and Phosphorous Estimation Methods within the Chesapeake Bay Watershed. 2011. Meeting of the Chesapeake Bay Program Ag Working Group. Annapolis, MD.
35. Spray-on-demand with treated and filtered municipal wastewater: Results of a one-year pilot study. 2011. Meeting of the Delaware Nutrient Management Commission. Dover, DE.
36. Nutrient removal methods for Concentrated Animal Feeding Operation runoff. 2010. Chesapeake Goal Line 2025: Opportunities for Enhancing Agricultural Conservation. Hunt Valley, MD.
37. Mechanical systems and automation to enhance the ergonomics of aquaculture. The 2010 Agrability National Training Workshop. Charleston, WV.
38. Feasibility of renewable energy and power purchase agreements for the food manufacturing industry. 2010. The 2010 Pickle Packers International Annual Conference. Philadelphia, PA.
39. An overview of lima bean harvesting research and recommendations. 2009. The Lima Bean Forum. Georgetown, DE.
40. Equipment research at the University of Delaware. 2009. Delegation from the Chinese Consulate, Washington, D.C.

41. Equipment, maintenance, and safety considerations in the installation of on-site waste treatment systems. 2009. The annual meeting of the Delaware On-Site Wastewater Treatment Association. Dover, DE.
42. Design recommendations to improve the safety of portable, metal climbing structures. 2008. The annual meeting of the American National Standards Institute (ANSI), Subcommittee 14.2. Chicago, IL.
43. Machine design in vegetable production and harvesting: A review of 100 years of engineering innovation and design. 2007. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
44. Preventing hand and arm injuries through limited exposure and new low vibration tool technology. 2007 Delaware Safety Association Annual Meeting, Ocean City, MD.
45. Reducing vibration-related injuries from hand and power tools. 2006 National Ergonomics Conference and Exposition. Las Vegas, NV.
46. Ladders – Summary of testing and forensics of failures. 2006. Consumer Union, Inc. Headquarters (Publishers of Consumer Reports Magazine). Yonkers, NY.
47. Measuring the potential for noise and vibration injuries in industrial settings. 2006 Eastern Ergonomics Conference and Exposition. Boston, MA.
48. Assessing and preventing ladder accidents. 2006 Delaware Safety Association Annual Meeting, Ocean City, MD.
49. Demonstration of a new cost effective surveillance system for Delaware water bodies. 2005. Scientific and Technical Advisory Committee, Center for the Inland Bays. University of Delaware, Lewes, DE.
50. Automation requirements for retaining pickling cucumber production in the U.S. 2005 Pickle Packers International Annual Meeting, Baltimore, MD.
51. Developments in harvesting of specialty crops. 2005 AETC Conference, Invited Session on Specialty Crops, Louisville, KY.
52. Barriers to vegetable harvest automation. 2005. AETC Conference, Invited Session on Automation. Louisville, KY.
53. Workshop on hand-arm vibration and noise: Overview of current limits and strategies for reducing working exposure and injury. 2005 Eastern Ergonomics Conference and Exposition, New York, NY.
54. Engineered human protection: An overview of research at University of Delaware. 2004. DuPont Experimental Station, Wilmington, DE.
55. Overview of modern machine designs for mechanized harvest of processing peas. The 2004 ASAE Film Forum. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
56. Ten years of developments for mechanical harvesting pickling cucumbers. The 2004 ASAE Film Forum. 2004 ASAE International Meeting, Ottawa, Ontario Canada.
57. Theoretical and experimental evaluation of an adaptive controller design using off-line model-based prediction and a segmented injection line for resin flow control in VARTM. 2004. Office of Naval Research, Advanced Materials Intelligent Processing Center (AMIPC). Newark, DE.
58. Progress in developing automated equipment for the simulation of human falls. 2004. DuPont Experimental Station, Wilmington, DE.
59. Improving mold part quality through automation and control: Progress and future challenges. 2004. National Science Foundation Invited Workshop Participant: Future of Modeling in Composites Molding Processes. The National Science Foundation, June 9 and 10, 2004, Alexandria, VA.
60. Progress in spatial and temporal surveillance technology for agricultural and environmental monitoring in Delaware. 2004. Department of Geography, spring 2004 Colloquium. Newark, DE.
61. Design and development of near-real-time whole water column surveillance systems for Delaware estuaries. 2004. Scientific and Technical Advisory Committee, Center for the Inland Bays. College of Marine Studies, University of Delaware, Lewes, DE.
62. Engineering aspects of production and mechanization for fresh and processed vegetables. 2003. Workshop on Recent Advances in Machine Harvesting of Fruits and Vegetables. The 100th Annual International Conference of the American Society for Horticultural Sciences. Providence, Rhode Island
63. Technical and strategic advances in vegetable mechanization. 2003. Colloquium: The U.S. Vegetable Industry Past and Future: Highlighting Advances, Challenges, and Opportunities in Vegetable Crop Management. Proceeding of the 100th Annual International Conference of the American Society for Horticultural Sciences. Providence, Rhode Island (co-presenter with E. Kee).
64. Adaptive control options for liquid composite resin injection. 2002. Office of Naval Research Meeting at the Center for Composite Materials, Newark, DE.
65. Performance of soy-based hydraulic fluids in long-term pump tests. 2001. Annual Meeting of the United Soybean Board Industrial Uses Committee. United Soybean Board, Chicago, IL (co-presenter M. Keefe).
66. Machine harvest: Research and field experiences on Delmarva and production systems, comparative tests of the Raven vs. the PicRyte Harvester, and improving tractor mounted harvesters. 2000. The Pickling Cucumber

Improvement Committee (PCIC) Spring Meeting of the Pickle Packers International, Newark, DE. (E. Kee, J. Glancey and J. Adkins).

67. Current machine design research projects including harvester improvements, automated pale filing, and electronic and digital sorting of pickles. 2000. The Pickling Cucumber Improvement Committee (PCIC) Spring Meeting of the Pickle Packers International, Newark, DE. Demonstrations held on the University of Delaware campus. (Glancey and Kee).
68. Development of a precision manure spreader for improved nutrient management. 1999. Agricultural Computer Expo, Lancaster, PA.
69. Progress in developing a soyoil based hydraulic fluid. 1999. Annual Meeting of the United Soybean Board Industrial Uses Committee. United Soybean Board, Chicago, IL (co-presenter Keefe and J. Gooch (DuPont).
70. Weld design and specifications: An engineer's perspective. 1999. Meeting of the American Welding Society, Delaware Section, Newark, DE.
71. A low volume fluid power test standard for hydraulic fluid testing. 1998. The Lubrizol Corporation, Wickliffe, OH.
72. A soyoil based hydraulic fluid: Advantages and limitations. 1998. United Soybean Board, Chicago, IL, Annual Meeting of the United Soybean Board Industrial Uses Committee (co-presenter S. Knowlton).
73. Mechanical harvesting: Current issues and where should we go from here? 1997. 104th Pickle Packers International Annual Meeting, Las Vegas, NV. (E. Kee presented on my behalf since I could not attend).
74. Progress in cucumber harvester research. 1997. Block and Guggenheimer Foods Inc. Annual Growers Meeting, DuPont Country Club, Seaford, DE.
75. An overview of pod stripper combine research at University of Delaware. 1997. FMC Corporate Headquarters, Chicago, IL.

Research Presentations at Professional Meetings & Conferences

1. Glancey, J., M. Baust, P.E., and E. Kee. Using Treated Municipal Wastewater for Agriculture: A Review of a Pilot Study and Regulations in Delaware. 2015. 2015 NABEC Annual Conference. Newark, DE
2. Glancey, J., B. Brown, E. Kee, M. Davis, L. Towle, Comparison of methods for estimating nutrient generation within the Chesapeake Bay Watershed. 2015. 2015 NABEC Annual Conference. Newark, DE
3. Glancey, J., M. Baust, P.E., B. Carbaugh, E. Kee, and K. Branner. 2011. Using treated municipal wastewater for agriculture: a review of a pilot study and regulations in Delaware. 4th International Symposium on Global Issues in Nutrient Management Science, Technology and Policy. Newark, DE.
4. Glancey, J., B. Brown, E. Kee, M. Davis, L. Towle, J. Timmons, and J. Nelson. 2011. Comparison of methods for estimating poultry manure nutrient generation within the Chesapeake Bay watershed. 4th International Symposium on Global Issues in Nutrient Management Science, Technology and Policy. Newark, DE.
5. Alms, J., J. Glancey and S. Advani. 2009. Mechanical properties of composite structures made with the vacuum induced preform relaxation process. The American Society for Composites, Twenty-fourth Technical Conference. Newark, DE.
6. Brisach, D., J. Alms, J. Glancey and N. Cloud. 2009. Integrated cut performance and sample inspection system for microtome setup evaluation. DETC 2009-87521. The ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, CA.
7. Ciappi, R. B. Miller, S. Petfield, C. Uthgenannt, J. Glancey, K. Smith and M. Harkcom. 2009. Design of a protective curtain system for high rotational speed disc mowers. The ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, CA.
8. Alms, J., J. Glancey and S. Advani. 2009. Development of computer controlled flow manipulation for vacuum infusion processes. ICCM-17, the International Committee on Composite Materials, Edinburgh, Scotland.
9. Alms, J., J. Glancey and S. Advani. 2009. Sequential injection using a gantry positioning system for flow control in vacuum resin infusion processes. The 2009 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
10. Alms, J., J. Glancey and S. Advani. 2008. Experimental determination of permeability of woven fiber glass during the vacuum induced preform relaxation (VIPR) process. The 9th International Conference on Textile Composites (TEXCOMP9). Newark, DE.
11. Alms, J., J. Glancey and S. Advani. 2008. Experimental validation of a port based injection methodology for vacuum infusion processes. The 2008 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Long Beach, CA.

12. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9), July 7th to 9th, Montreal, Quebec, Canada.
13. Collins, S., D. Erickson, S. Mabel, D. Shannon, K. Smith and J. Glancey. 2008. Design and prototyping of a hydraulic hose and cable organizer for mobile equipment. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
14. Dibelka, J., M. Steimer, L. Traub, J. Twomey, S. Woods, S. Phillips, and J. Glancey, 2008. Design of a heat removal method for the electronics in lithium-ion cordless power tools. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
15. Glancey, J. 2008. Mechanical harvesting characteristics of several leafy greens grown for processing. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
16. Pearson, E. J. Woodhouse, B. Miller, R. Strosser and J. Glancey. 2008. Performance of a prototype steer-by-wire driving system for self propelled windrowers. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
17. Stewart, S., J. Armstrong, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester and J. Glancey. 2008. Mechanical harvesting system for improving the ergonomics for in-door, closed system, live market tilapia production. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
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24. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9) will be held from July 7th to 9th 2008, in Montreal, Quebec, Canada.
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27. Brisach, D., M. Griffith, J. Konchar, S. Petfield, P. Popper, and J.L. Glancey. 2007. Attenuation of impact and continuous vibration in the hand and arm. The ASME International Design Engineering Technical Conferences: The 21st Biennial Conference on Mechanical Vibration and Noise, & Applications of Vibration and Acoustics in Biomedical Engineering. Las Vegas, NV.
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35. Fuqua, M. and J.L. Glancey. 2007. The Effects of in-tool resin delivery ports on process control and molded part quality for vacuum-based composite manufacturing. The Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
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44. Brisach, D., M. Griffith, P. Popper and J. Glancey. 2007. Measurement of vibration transmission in the hand and arm from impact and continuous vibrating sources. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
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48. Konchar, J., P. M. Griffith, P. Popper, and J.L. Glancey. 2006. Modeling and testing of a new polymer-based impact tool design to reduce biomechanical injuries. 2006 ASME International Annual Meeting, Chicago, IL.
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57. Kasprzak, S., M. Fuqua, J. Nasr, and J.L. Glancey. 2006. A real-time resin flow modification robot for vacuum-assisted resin transfer molding of composite materials. The Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
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60. Nalla, A. and J.L. Glancey. 2005. Closed loop control of resin flow in VARTM using a multi-segment injection line and real-time adaptive, model-based control. The 2005 ASME International Mechanical Engineering Congress and R&D Expo, Orlando, FL.
61. Stewart, S., J. Armstrong, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester and J. Glancey. 2005. Mechanical harvesting aids for indoor, closed system tilapia production. 2005 National Agrability Conference, Burlington, VT.
62. Glancey, J.L. 2005. Design and performance of a hydro-unloading system for machine harvested vegetables. 2005 ASAE International Annual Meeting, Orlando, FL.
63. Glancey, J.L., J. R. Vinson, and G. A. Snyder. 2005. Assessing ladder accidents. 2005 ASAE International Annual Meeting, Orlando, Florida.
64. Glancey, J.L., P. Popper, and J. Konchar. 2005. Ergonomic benefits of polymer capped chisels. 2005 ASAE International Annual Meeting, Orlando, FL.
65. Glancey, J.L., K. Carlisle, and W. Carlisle. 2005. High speed mechanical harvesting of spinach. 2005 NABEC Conference, Lewes, DE.
66. Kasprzak, S., M. Fuqua, M. Griffith, J. Nasr, and J. L. Glancey. 2005. An overview of composite manufacturing processes and applications. 2005 NABEC Conference, Lewes, DE.
67. Meckley, D., K. Smith, E. Priepke, and J. Glancey. 2005. A hydraulic powered bale kicker for large round balers. 2005 NABEC Conference, Lewes, DE.
68. Dickerson, D., R. Benetiz, M. Baker, G. VanWicklen and J.L. Glancey. 2005. Automated testing of poultry nipple drinkers. 2005 NABEC Conference, Lewes, DE.
69. Brown, D., D. Jones, and J.L. Glancey. 2005. Measurement of embryo temperature in incubating avian eggs. 2005 NABEC Conference, Lewes, DE.
70. Herseim, R., K. Comer, T. Stiefvater, and J. Glancey. Structural analysis and testing of injected molded plastic drive train shields for self-propelled mower conditioners. 2005 NABEC Conference, Lewes, DE.
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72. Konchar, J., J. Glancey, P. Popper. 2005. Sound emission characteristics of new hand-struck tools designed with high performance engineering polymers. 2005 NABEC Conference, Lewes, DE.
73. Glancey, J.L., G. Snyder, J. Vinson, J. Krishnan, P. Franklin. Dynamic loading of fiberglass step ladders. 2005 NABEC Conference, Lewes, DE.
74. Glancey, J.L., R. Strosser, I. Cosden, M. Dunson, J. Gordon, and D. Cook. 2005. Automatic adjustment and control of the conditioning roll gap on mower-conditioners. 2005 NABEC Conference, Lewes, DE.
75. Lynch, S., W. F. Ritter, and J. Glancey. 2005. Potential economic impacts of the biodiesel industry in Delaware. 2005 NABEC Conference, Lewes, DE.
76. Smith, K., G. Thorson, J.L. Glancey, and S.Huerta. 2005. Real-time surveillance of shallow depth estuaries for water quality and harmful algal blooms. 2005 ASCE Watershed Management Conference, Williamsburg, VA.

77. Konchar, J. and J. L. Glancey. 2005. Strategies for reducing hearing loss in industrial workers. 2nd Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
78. Krisher, J. and J.L. Glancey. 2005. Modeling the impact of human falls. 2nd Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
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80. Vinson, J., J. L. Glancey, and G. A. Snyder. 2004. Analysis, design and optimization of high performance composite sandwich water skis. The 2004 ASME International Mechanical Engineering Congress and R&D Expo, Los Angeles, CA. (presented by J. Vinson).
81. Smith, K. and J. L. Glancey. 2004. Design and testing of a low-cost whole water column, near-real-time surveillance device for shallow depth estuaries. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
82. Glancey, J.L., W.E. Kee, and T.L. Wootten. 2004. Effects of plant architecture on the mechanical recovery of bush-type vegetable crops. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
83. Glancey, J.L. and T. Nasr. 2004. Measurement of transmitted vibration in tools designed using engineering polymers. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
84. Herseim, R., J.L. Glancey, P. Popper, W. Walker, K. Ranjan, and J. Tretacosta (DuPont, Co.). 2004. A device to simulate the mechanics of human falls. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
85. Herseim, R., J. Moore, and J. L. Glancey. 2004. An instrumented device for measuring the dynamics of human falls. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
86. Smith, K., G. Thorson, and J. L. Glancey. 2004. Progress in developing low cost, near-real-time surveillance systems for water quality monitoring in Delaware. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
87. Nalla, A., J.L. Glancey and B. Leleiver. 2004. Theoretical and experimental evaluation of a segmented injection line for resin flow control in VARTM. The 7th International Conference on Flow Processes in Composite Materials, USA, 7 ~ 9 July, Newark, DE..
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89. Moore, J., J. Lawrence, and J.L. Glancey. 2004. A test stand and standard testing methodology for measuring the hand-arm vibration characteristics of power tools. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
90. Muhlenforth, D., D. Schiavoni, and J. L. Glancey. 2004. Spectral analysis of new, low vibration hand-struck tool designs. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
91. Herseim, R. and J. L. Glancey. 2004. The mechanics of human falls. 1st Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
92. Tuday, B., J. Fitzgibbons, S. Davidson, and J. L. Glancey. 2004. Design requirements for an automated measurement system for the evaluation of progress during hand and finger physical therapy. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
93. Humphries, E. (Delaware Department of Natural Resources and Environmental Control - DNREC), et. al. (DNREC presenter on behalf of all University of Delaware and DNREC researchers). 2003. State of Delaware 2003 harmful algae bloom initiative- summary of current research and partners. 2nd Symposium on Harmful Marine Algae in the U.S., Woods Hole, MA.
94. Glancey, J.L., G.A. Snyder (National Forensic Engineers, Inc.), and J.R. Vinson. 2003. Experimental evaluation of the structural characteristics of extruded aluminum stepladders. The ASME International Design Engineering Technical Conferences: 17th Reliability, Stress Analysis and Failure Prevention Conference, Chicago, IL.
95. Snyder, G.A. (National Forensic Engineers, Inc.), J.L. Glancey, and J.R. Vinson. 2003. Failure analysis of stepladders manufactured from extruded aluminum. The 2003 ASME International Mechanical Engineering Congress and R&D Expo, Washington, D.C.
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98. Wang, J., J.L. Glancey, and J.R. Vinson. 2002. Transverse shear deformation effects in laminated and sandwich composite panels subjected to in-plane shear. ASME IMECE, New Orleans, LA.

99. Wang , J., J.R. Vinson., and J.L. Glancey. 2002. Geometric nonlinear deformation effects in composite sandwich plates subject to in-plane shear loads ASME IMECE, New Orleans, LA.
100. Glancey, J. L. 2001. Digital signal processing of the storage bin mass on mobile equipment for the prediction of crop mass flow rate and yield. The 2001 ASAE International Annual Meeting, Sacramento, CA.
101. Keefe, M., J.L. Glancey, and Z. Zhong. 2000. Performance of high oleic soybean oil-based hydraulic fluids in long-duration pump tests. The 2000 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
102. Krishnan, M., R. Strosser, J.L. Glancey and J.Q. Sun. 2000. Adaptive modeling and control of precision agricultural machines. The 2000 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
103. Glancey, J.L., S. Knowlton, E.R. Benson. 1999. Development of a high oleic soybean oil-based hydraulic fluid. The 1998 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
104. Glancey, J.L., J.K. Rosenberger, and S.S. Cloud. 1999. Measurement of embryo and air cell temperatures in incubating broiler eggs. Abstract #9938. The 10th Annual Northeast Agricultural and Biological Engineering Conference, Lancaster, PA.
105. Knowlton, S (DuPont), and J.L. Glancey. 1998. Development of a high oleic soybean oil-based hydraulic fluid. 1998. The 89th Annual Meeting of the American Oil Chemists Society. May 1998, Chicago, IL.
106. Glancey, J.L., D.W. Hofstetter, W.E. Kee and T.L. Wootten. 1998. Yield and soil property variations in processed vegetable production on the Delmarva Peninsula. The 1998 ASAE International Annual Meeting. Orlando, FL.
107. Glancey, J.L., W.E. Kee, T.L. Wootten and D.W. Hofstetter. 1998. Feasibility of once-over mechanical harvest of processing squash. The 1998 ASAE International Annual Meeting. Orlando, FL.
108. Glancey, J.L., D. Hoffstetter, W.E. Kee, T.L. Wootten, and M. Lynch. 1997. Preliminary evaluation of yield monitoring techniques for vegetables. 1997 ASAE International Annual Meeting, Minneapolis, MN.
109. Glancey, J.L., S. Seymour, C. Bohman, R. Sheehan, and J. Posselius (New Holland, Inc.). 1997. Development of a precision industrial spreader for the land application of solid wastes. 1997 ASAE International Annual Meeting, Minneapolis, MN.
110. Glancey, J.L., W.E. Kee, and T.L. Wootten. 1997. Reducing damage and improving recovery of mechanically harvested pickling cucumbers. 1997 ASAE International Annual Meeting, Minneapolis, MN.
111. Glancey, J.L., W.E. Kee, T.L. Wootten. 1997. Modeling recovery of pod stripper combines used for the mechanical harvesting of processed vegetables. The 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
112. Kee, W.E., T.L. Wootten and J.L. Glancey. 1997. Production systems to optimize mechanical harvest of pickling cucumbers. The 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
113. Glancey, J.L. 1997. Yield monitoring techniques for lima beans harvested with pod stripper combines. The Biennial Meeting of the Bean Improvement Cooperative, Annapolis, MD.
114. Glancey, J.L. 1997. Yield monitoring of peas with pod stripper combines. The Biennial Meeting of the Pea Improvement Cooperative, Annapolis, MD.

TEACHING PRESENTATIONS AT PROFESSIONAL MEETINGS & CONFERENCES

1. Glancey, J.L. 2006. Faculty and industry partnerships through sponsored research and design projects targeted to enhance undergraduate education. The 2006 ASABE International Annual Meeting, Seattle, WA.
2. Keefe, M., J.L. Glancey, and N. Cloud. 2005. A Case Study In Assessing Team-Based Design Courses That Integrate Industry-Sponsored Projects. The 2005 International Mechanical Engineering Congress and Exposition, Orlando, FL.

FUNDED RESEARCH PROJECTS

1. Developing Irrigation BMP's for Spray on Demand with Municipal Wastewater. Delaware Department of Agriculture and Delaware Department of Natural Resources and Environmental Control. 2010-11.
2. Advanced Materials Manufacturing: Rapid Tooling for Large Scale Composite Structures-Phase I. Gillespie, Advani, et.al. Office of Naval Research. 2009-11.
3. Advanced Materials Intelligent Processing-Phase VI. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. 2003-05. $1,025,000.
4. Development of Near-Real-Time Whole Water Column Surveillance Technology for Shallow Depth Estuaries. Delaware Department of Natural Resources and Environmental Control, and The Center for the Inland Bays - $30,500, and University of Delaware, College of Agriculture and Natural Resources Research Match - $29,500.

5. Advanced Materials Intelligent Processing-Phase V. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. 2003-04. $1,300,000.
6. Development of Hip-Impact Simulation Device. 2003- present. DuPont, Inc. $22,000.
7. Improving Hand and Power Impact Tool Performance with Engineering Polymers. 2003-04. Hard Hat, LCC. $9,000.
8. Feasibility of Automation for Medical Sensor Manufacturing Inspections. 2003. Dade Behring, Glasgow, DE. $5,000.
9. Propulsion Control for the New Holland Power Units. 2002-03. New Holland, NA, New Holland, PA. $10,000. (with J.Q. Sun).
10. Improving Performance of Commercial Avian Incubators through Innovative Measurement and Control of Embryo Temperature. 2002-04. U.S. Poultry and Egg Association. $48,000.
11. Advanced Materials Intelligent Processing- Phase IV. 2002-03. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. $1,300,000.
12. Design of a Solar House for the Solar Decathlon Competition. 2001. U.S. Dept. of Energy (co-investigator w/ L.P. Wang and A.J. Prasad). $5,000.
13. Adaptive Controls for New Holland Demeter Machines. 2000-2002. CNH Global - Haytools $20,000. (with J.Q. Sun).
14. Chemical Analysis of Used High Oleic Soyoil Hydraulic Fluid. 2001. DuPont. $20,000 (with M. Keefe).
15. Preliminary Control, Analysis and Design of New Holland Demeter Machines. 2000. CNH Global - Haytools $8,000 (Co-investigator w/ Jian Sun).
16. Gift from Pickle Packers International. 1999. $5,000. (E. Kee and J. Glancey).
17. Testing Soyoil-Based Hydraulic Fluids. 1999-2001. The United Soybean Board $25,000. DRP $25,000. (Joint project with DuPont, M. Keefe and A. Szeri).
18. Noise Reduction on the New Holland Skid Loader. 1999. New Holland, N.A., Inc. $20,000 (2nd investigator with Jian Sun).
19. Demonstration of Improved Configurations for Cucumbers Harvesters. 1998-99. Delaware Vegetable Growers Check-Off: $22,000; and the Delaware Research Partnership: $22,000.
20. Calibration of a Microwave Yield Sensor. 1999. New Holland N.A., Inc. $6,000.
21. Development of a Phosphorous-Index for the Management of Fertilizer and Poultry Manure P. 1999-2001. $50,000 (Delaware Department of Natural Resources and Environmental Control - DNREC, the State of Maryland). (J.T. Sims, Principle Investigator).
22. Development of a High Oleic Soybean Oil-Based Hydraulic Fluid. 1997-1999. DuPont: $45,000; and the Delaware Research Partnership: $32,000
23. Development of a Precision Industrial Spreader. 1997-98. DNREC: $39,500, New Holland, N.A., Inc.: $49,000.
24. Mechanical Harvester Improvement Program. 1997-2001. Pickle Packers International, Inc. $20,000. (with Ed Kee).

INTELLECTUAL PROPERTY

- Patents Awarded
  1. *System and Method for Controlling Permeability in Vacuum Infusion Processes.* U.S. Patent No. 9,079,367. 2015.
  2. *Computer Controlled Flow Manipulation for Vacuum Infusion Processes.* U.S. Patent No. 8,808,612. 2014
  3. *Apparatus and Method for Preform Relaxation and Flow Control in Liquid Composite Molding Processes.* U.S. Patent No. 8,210,841. 2012.
  4. *An Automatic Control System for Vegetable Harvesters*. U.S. Patent No. 5,784,871. 1999.

- Provisional Patents, and Patent Applications Submitted and/or Under Review at the U.S. Patent Office
  1. *A Method for Separating Oil from Water*. U.S. Provisional Patent No. 61/370,067.
  2. *Apparatus and System for Magnetically Controlling Permeability in a Vacuum Infusion Process*. U.S. Provisional Patent No. 61/376,893.
  3. *Twist-Lock Mechanism for Attaching Composite Impact Surfaces to Impact Tools.* U.S. Provisional Patent No. 61/255.331.
  4. *Combination of Impact Tool Cap and Shaped Relatively Low Modulus Material*. U.S. Patent Application No. 12/083903.
  5. *A Functional Polymer Faced Hammer for Reduced Vibration, Noise, and Improved Ergonomics*. U.S. Patent Application No. WO 2007/082238.

6. *Snap-off Blade Knife with Safety Stop*. U.S. Patent Application No. 12/509085
7. *Vacuum Assisted Resin Transfer Molding Techniques with Flood Flow Chamber for Composite Material Manufacturing*. U.S. Patent Application No. 11/458122.
8. *A Low Volume Testing Device to Evaluate Hydraulic Fluid Performance*. U.S. Patent Application No. 09/256,060. (patent application withdrawn by UD).
9. *Direct, Continuous Measurement of the Mass Flow Rate of Bulk Materials*. U.S. Provisional Patent Application No. 60/094,543.

- Additional Invention Disclosures and Applications

10. *A High Oleic Soybean Oil-Based Biodegradable, Non-Toxic Hydraulic Fluid*. (Provisional Patent submitted by DuPont).
11. *An Applicator for Metering Bulk Solid Wastes and Compost in Rows.* (Provisional Patent submitted by New Holland, Inc. N.A.).

PROFESSIONAL CONSULTING

- Expert Witness – *Deposition & Court Testimony*

1. *Mussumecci v. Werner Co.*, Case No. HNT-L-642-02 (Superior Court of New Jersey) (deposition and court appearance)
2. *Kasper v. Tricam Industries, Inc., Walgreen Company, and Home Depot, Inc.*, Case No. 05 L 0001444 (Circuit Court of Cook County, Illinois) (deposition);
3. *Arancibia v. Core Distribution, Inc. and Home Depot U.S.A., Inc*., Case No. 10-CV-05807-ADS-AKT (District Court of New York, Eastern District) (deposition);
4. *Abbate v. Werner Company and Home Depot U.S.A., Inc.*, C/A No. 09C-02-013 (Superior Court of Delaware) (deposition);
5. *Kahn v. Macklanburn-Duncan Company*, C/A No. 07-CP-1512 (Common Pleas 14th Judicial Court of South Carolina) (deposition);
6. *Bethea v. S.P. Richards & SDI Corporation*, Case No. 4:06-CV-2604-TLW-TER (District of South Carolina, Florence Division), (deposition)
7. *Uli v. Lowe's HIW, Inc.*, Case No. 34-2009-00038666 (Superior Court of California, County of Sacramento); (deposition)
8. *Ford v. Werner Company and Home Depot U.S.A., Inc.*, Case No. ED CV 05-00988 SGL (District of California, Eastern Division), (deposition and court appearance);
9. *Campos v. Louisville Ladder, Inc.*, Civil Action No. C-09-39 Jury, (Southern District of Texas, Corpus Christi Division) (deposition);
10. *Flores v. Lynn Ladder & Scaffolding Co., Inc., Capital Rental Inc., and TCR Mid-Atlantic Construction*, Law No. CL06-5310 (Circuit Court of Fairfax, Virginia), (deposition and court appearance);
11. *Chenault et al. v. Doral Industries Inc., Costco Home & Office Products Inc., Walmart Stores Inc., and Sam's Club*, Case No. 1:08-cv-00354-SS (Western District of Texas, Austin Division) (deposition and court appearance);
12. *Yoder et al. v. The Sportsman's Guide, Inc.*, No. 14-cv-00937 (Western District of Pennsylvania) (deposition);
13. *Fitzner v. New Werner Holding Co., Inc. et al.*, No. SX-09-cv-400 (Superior Court of the Virgin Islands) (deposition);
14. *Foster v. Tricam Industries & Home Depot U.S.A., Inc.*, No. 11-cv-00338 (District of Utah) (deposition and court appearance);
15. *Leach v. Core Distribution, Inc. et al.*, No. 10-cv-02570 (District of Colorado) (deposition and court appearance);
16. *Jackson v. Louisville Ladder, Inc. et al.*, No. 11-cv-1527 (Middle District of Pennsylvania) (deposition and court appearance);
17. *Hodge v. Louisville Ladder, Inc. et al.*, No. 12-cv-00240 (Southern District of Texas) (deposition and court appearance);
18. *Picken v. Cuprum S.A. de C.V. et al.*, No. 11-13044 (Eastern District of Michigan) (deposition and court appearance);
19. *Ash v. Reber & Reber (3rd Party Plaintiff) v. Tricam Industries et al.*, No. 145499/2012 (Supreme Court Niagara County, New York) (deposition and court appearance);
20. *Coon v. NK Co. Ltd. et al.*, No. UNN-L-1809-10 (Union County Superior Court, New Jersey) (deposition and court appearance);
21. *Privado v. Vestil Manufacturing Corporation*, No. 7:16-cv-00649 (Southern District of Texas) (deposition);

22. *Privado v. AIM Media Texas Operating, LLC,* No. JWA NO. 994-A 2016 (Southern District of Texas), (deposition);
23. *Bocelli v. Owens & Minor Distribution Inc. and Crown Equipment Corp.*, No. 2:15-cv-06313-NIQA (Eastern District of Pennsylvania) (deposition);
24. *Blackbird Technologies LLC v. Lenovo PC International,* C.A. No. 16-140-RGA (District Court for the District of Delaware) (deposition);
25. *Deem v. Barnett Outdoors, LLC,* C.A. 5:18-cv-582 (District Court for the Western District of Texas, San Antonio Division) (deposition);
26. *Lopez v. RGV Lava-wash Cleaning Services, LLC.* CASE NO. C-2151-18-D. (District Court for the Western District of Texas, San Antonio Division) (deposition);
27. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants)*. C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 8,813,663 & 9,861,031. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
28. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants)*. C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,699,955 & 10,004,173. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
29. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants)*. C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,807,922 & 9,480,199. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
30. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants)*. C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,686,906 & 9,807,924. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
31. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants)*. C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patent 9,820,429. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
32. *Steuben Foods, Inc. (Plaintiff) vs. Shibuua Hoppman, LLC. and HP Hood LLC (Defendants).* Case No. CV-00781-WMS-JJM. (District Court for Delaware). U.S. Patent Numbers: 6,209,591, 6,536,188 and 6,702,985. Defendant Attorney: Byron Pickard, Sterne, Kessler, Goldstein & Fox P.L.L.C., Washington, D.C. (deposition and trial);
33. *Juki America, Inc. et al. (Plaintiff). vs. ABM International, Inc. (Defendant).* Case No. IPR2020-01371, -01372, and -01373). Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Numbers: 9,840,797, 10,100,449, and 10,240,270. Defendant attorney: Mike Berchou, Harter Secrest & Emery LLP, Buffalo, NY (deposition);
34. *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Meridian Manufacturing Corp. (Defendant).* Case No. 5:19-cv-4005. (District Court for Iowa). Infringement of Agricultural Seed Carrier with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of the Plaintiff. Plaintiff Attorney: Joseph Hines, Esq., Rothwell Figg, Washington, D.C. (deposition).
35. *Clayton (Plaintiff) vs. Heil Company, Inc. (Defendant).* Case No. CV-19-04724-PHX-GMS. (District Court for Arizona). Plaintiff Attorney: John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. (deposition);
36. *Olati LLC (Plaintiff) v Hass Automation (Defendant)*. Case No. IPR2021-00146. (District Court Central for California Western Division). Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Number 8,136,432. Working on behalf of the Plaintiff. Plaintiff Attorney: Matt Holohan, Esq., Sheridan Ross, PC., Denver, CO. (deposition);
37. *Kamm (Plaintiff) vs. Stellar, et al. (Defendant).* Case No. CV-19-05172-PHX-SPL. (District Court for Arizona). Working on behalf of the Plaintiff. Plaintiff Attorney: Matt Holohan, Esq., Sheridan Ross, PC., Denver, CO. (Deposition);
38. *John Deere (Plaintiff) v AGCO and Precision Planting (Defendants). C.A. No. 18-827 (CFC) (Consolidated).* District Court of Delaware. Infringement of Plaintiff Patents 8813663 and 9699955. Working on behalf of Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition and trial);
39. *Palmer (Plaintiff) v Stanley Black and Decker (Defendant).* Case No. 20-cv-1084. (Middle District Court of Pennsylvania). Working on behalf of the Plaintiff. Plaintiff Attorney: Wayne Marvel Esq., Maron, Marvel, Bradley, Anderson, & Tardy LLC. Wilmington, DE. (trial only).

40. *Pentz (Plaintiff) vs. Werner Ladder (Defendant).* Civil No. 210900435. Working on behalf of the Plaintiff District Court of Utah. Plaintiff Attorney: Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. (deposition).
41. *Parents of the Estate of Kaidon Montgomery (Plaintiff) vs. Kids2, Inc. et.al. (Defendant).* Civil No. No.: 3:21-CV-166. District Court of Western Pennsylvania. Working on behalf of the Plaintiff. Plaintiff Attorney: Thomas Bosworth, Esq., Klein and Specter, P.C. (deposition).
42. *Tomassetti (Plaintiff) vs. Little Giant Ladder (Defendant).* Case No. 22-CV-2587(VB). Working on behalf of the Plaintiff. Plaintiff Attorney: Terry McCarty, Esq., Reiner, Slaughter, McCartney & Frankel LLP., Rye, NY. Terry McCartney, (3-part deposition).
43. *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants).* Case No. 4:2020cv00389. District Court of Iowa. Working on behalf of Plaintiff. Infringement and Validity of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Nathan Mammen, Kirkland and Ellis LLP, Washington, D.C. (deposition and 2 trial appearances).
44. *Norge Holdings, LLC and Alien Technologies Corp. (Plaintiffs), vs John D. Cullinan and Lynx Precision Products Corp. (Defendant).* District Court of Southern Ohio, Western Di, , vision. Infringement and Validity of a Sports Utility Vehicle Hard Top Removal Device Patent, U.S. Patent Number US9,643,823. Testimony and declaration in support of Plaintiff's Temporary restraining order and preliminary injunction. Working on behalf of Plaintiff. Eric Gaum, Taft, Cleveland, OH. Case No. 1:20-CV-00918-MVM. (court testimony).
45. *James Rowedder v. Primal Vantage Company, Inc., and Dick's Sporting Goods. Inc. d/b/a Field & Stream*. District of South Carolina, Charleston Division. Working on behalf of Plaintiff. Ronnie Crosby, Parker Law Group, LLP, Hampton, S.C. Civil Action No.: 2:22-cv-2371-RMG. (deposition)
46. *Alicea (Plainiff) v. Gorilla Ladder Company, Tricam Industries, Inc., Home Depot USA, Inc. and L. Valetin* (Defendants). Supreme Court of New York, County of Bronx. Working on behalf of Plaintiff. Terry McCartney, McCartney Stuckey LLC., Rye, NY. Index No. 304567/2015. (trial)
47. *Telebrands Corp. (Plaintiff) v Winston Products LLC (Defendant),* Northern District Court of Ohio. Testimony and declaration(s) in support of Plaintiff's claim construction for a Markman hearing. Working on behalf of Plaintiff. Vincent Ferrero, Esq., Kelley Drye & Warren LLP, Parsippany, NJ. U.S. Patent Numbers: 10,174,870, 10,890,278, and 11,608,915. Case No. 1:23-cv-00631-BMB. (Markman deposition)

- Expert Witness – *Patent Infringement, Validity & Other Patent Litigation Matters*
  1. Williams and Connolly, Washington, D.C. (2024). Multifold International Inc. PTE. LTD (Plaintiff) v Google, Inc. (Defendant), Working on behalf of Defendant. U.S. Patent Numbers: 8,854,834 and 9,665,126. District Court of Delaware. Case No. 1:23-cv-01323-JLH.
  2. Crowell and Moring, Chicago, IL. (2024). *Willo Products Company, LLC v. Habersham Metal Products Company,* Working on behalf of Plaintiff. U.S. Patent Number: 10,385,587. Northern District Court of Georgia. Civil Action No. 2:23-cv-138-RWS
  3. Cline Williams Wright Johnson & Oldfather, L.L.P., Lincoln, NE. (2023-present). *Automated Layout Technology, LLC v. Precisions Steel Systems, LLC, Donner Steel Works, Inc., and Nicholas Donner*, Working on behalf of Defendants. U.S. Patent Numbers: 10,576,588 and 11,426,826. Case No. 4:20- cv-3127.
  4. Kelley Drye & Warren LLP, Parsippany, NJ. (2023-present). Telebrands Corp. v Winston Products LLC, Working on behalf of Plaintiff. U.S. Patent Numbers: 10,174,870, 10,890,278, and 11,608,915. District Court for the Northern District of Ohio, Eastern Division. Case No. 1:23-cv-00631-BMB.
  5. Freeman Mathis and Gary, LLP, Las Vegas, NV. (2023-present). *Dae Sung Hi Tech Co., LTD, and First 2 Market Products, LLC v D&B Sales, Inc. et al.* Working on behalf of the Plaintiffs. U.S. Patent Number 7,503,696. District Court of Nevada. Case No. 2:22-cv-00030-ART-BNW.
  6. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2023-present). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Par-Kan (Defendant).* Infringement of Agricultural Seed Tender with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of Plaintiff. Case No. TBD
  7. Saul Ewing Arnstein & Lehr LLP, Chicago, IL. (2022-present). *Pipp Mobile Storage Systems, Inc. (Plaintiff) v Innovative Growers Equipment, Inc. (Defendant).* U.S. Patent Number 10,806,099. Working on behalf of the Defendants. Case No.: 1:21-cv-2104.
  8. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2022-2023). *Dynamic Motion Rides GMBH et al. 3(Plaintiffs) v. Universal City Development Partners Ltd. et al. (NBC Universal) (Defendants)*. U.S. Patent

Numbers: 9,259,657; 9,536,446; and 10,283,008. Working on behalf of the Defendants. Middle District Court of Central Florida, Orlando Division. Case No. 21-cv-752-RBDLRH (M.D. Fl.).

9. Kirkland & Ellis (2022-2024). *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants)*. Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. 4:2020cv00389.
10. Taft Stettinius & Hollister LLP. Cleveland, OH. (2021-present). Norge Holdings, LLC and Alien Technologies Corp., *(Plaintiffs) vs John D. Cullinan and Lynx Precision Products Corp*. *(Defendant)*. Infringement of a Sports Utility Vehicle Hard Top Removal Device Patent, U.S. Patent Number US9,643,823. Working on behalf of the Plaintiff. Case No. 1:20-CV-00918-MVM.
11. Sterne, Kessler, Goldstein & Fox P.L.L.C., Washington, D.C. (2020-2022). *Steuben Foods, Inc. (Plaintiff) vs. Shibuua Hoppman, LLC. and HP Hood LLC (Defendants)*. Infringement of *Several Aseptic Methods and Processing Machines.* U.S. Patent Numbers: 6,209,591, 6,536,188 and 6,702,985. Working on behalf of Defendant. Case No. CV-00781-WMS-JJM.
12. Harter Secrest & Emery LLP, Buffalo, NY (2020-present). ABM International, Inc (Plaintiff). vs. Juki America, Inc. et al. *Inter Partes Review* Expert in front of the Patent Trial and Appeals Board for U.S. Patent Number: 9,840,797. Working on behalf of Plaintiff. Case No. IPR2020-01371.
13. Nyemaster Goode PC, Des Moines, IA. (2020-21). *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants).* Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. 4:2020cv00389.
14. Harter Secrest & Emery LLP, Buffalo, NY (2020-present). ABM International, Inc (Plaintiff). vs. Juki America, Inc. et al. *Infringement* of U.S. Patent Number: 9,840,797. Working on behalf of Plaintiff. Case No. Case No. IPR2020-01371.
15. Covington and Burling, LLP, Washington, D.C. (2019-2021). *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of the Plaintiff. Case No's. IPR2019-01044, IPR2019-01046, IPR2019-01055, IPR2019-01053, IPR2019-01052, and IPR2019-01048.
16. Sheridan Ross, PC., Denver, CO (2020-present). *Olati LLC v Hass Automation*. Infringement of a Numerical Control Algorithm for Controlling Machined Surface Finish. U.S. Patent Number: 8,136,432. Working on behalf of the Plaintiff. Case No. IPR2021-00146.
17. Haley Guiliano, LLP, San Jose, CA (2019-present). *Cherokee Eagle LLC (Plaintiff) v Skyzone, LLC, et al. (Defendants)*. Infringement of an indoor trampoline arena. U.S. Patent Number: 8,764,575. Working on behalf of the Plaintiff. Case No. 6:18-cv-355-Orl-40TBS.
18. Taft Stettinius & Hollister LLP. Cleveland, OH. (2019-2020). *H.W.J. Designs for Agribusiness, Inc., and Samuel Strapping Systems, Inc. (Plaintiff) v. Rethceif Enterprises, LLC, Brown Company, Inc., D/B/A International Fiber Packaging (Defendant)*. Infringement of a Cotton Bale Wrapper and Sampler, U.S. Patent Numbers: 9,463,885 and 8,336,404. Working on behalf of the Defendant. Case No.1:17-CV-0272-AWI-SKO.
19. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2019-2022). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Meridian Manufacturing Corp. (Defendant)*. Infringement of *Agricultural Seed Carrier with Pivoting Conveyor*, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of the Plaintiff. Case No. 5:19-cv-4005.
20. Covington and Burling, LLP, Washington, D.C. (2018-22). *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. C.A. No. 18-872 (CFC) (consolidated).
21. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2018-19). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Norwood. (Defendant)*. Infringement of Agricultural Seed Tender with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of Plaintiff. Case No. 3:18-cv-00053.

22. David Gerasimow, Esq., Blackbird Technologies, Boston, MA. (2017-18). *Blackbird Technologies, Inc. (Plaintiff) vs. Lenovo Corporation (Defendant)*. Infringement of *Multipurpose Computer Display System*, U.S. Patent No. 7,129,931. Working on behalf of Plaintiff. C.A. No. 16-cv-140-RGA.
23. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2016-18). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. J&M Manufacturing Co., Inc. (Defendant)*. Infringement of *Agricultural Seed Carrier with Pivoting Conveyor*, U.S. Patent No. 8,221,047. Working on behalf of Plaintiff. Civil Action No. 3:16-cv-02282-JZ
24. Daneker, McIntire, Schumm, Prince, Manning & Widmann, P.C., Baltimore, MD. (2011). Testing to demonstrate infringement of Hard Cap™ patent by a foreign manufacturer. U.S. Patent No. 908,996.
25. Brooke Schumm, Esq., Baltimore, MD. (2010). Prototyping and reduction to practice of U.S. Patent No. 8,092,370.
26. Laura Simon, Esq., Dalton and Associates, Wilmington, DE. (2008) Prototyping and reduction to practice of U.S. Patent No. 6,957,510.

- Expert Witness – *Product Liability Litigation and Investigations, and Personal Injury Lawsuits*

1. Kevin O'Brien, Esq., Sampone O'Brien Dilsheimer Law, Cheltenham, PA. Engineering evaluation of an infant bassinet, changer and playard design related to SIUDS deaths. (2024).
2. Greer Ocilka, Esq., Marcus & Shapira LLP, Pittsburgh, PA. Polymer handle failure on a large coffee urn and associated injuries. (2024).
3. Will Owen, Esq., Musselwhite, Musselwhite, Branch & Grantham, P.A., Lumberton, NC. Dismemberment death from a large wood conveyor at a pallet mill. (2024).
4. Phillip Mazzotti, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Arm injury resulting from a turning lathe entanglement while wearing gloves. (2024).
5. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Analysis of a telescoping ladder structural failure. (2024).
6. Liam Duffy, Esq., Yarborough Applegate LLC, Charleston, S.C. Crushing death while servicing a panel cutting wood saw. (2014).
7. Jason Schiffman, Esq., Schiffman Firm, Pittsburgh, PA. Multiple finger amputations from a radial arm saw with an excessively long rundown time. (2024).
8. Wilson Jackson, Esq. & Elliotte Quinn, Esq., Steinberg Law Firm, LLC, Summerville, SC. Investigation of a death from a portable, engine powered chop saw. (2024)
9. Andrew Valentin, Esq., Schuster Law and Associates, Media, PA. Fall from an elevated work platform used for picking mushrooms. (2024).
10. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Failure analysis of a tree mounted hunting stand with a fixed ladder. (2024).
11. Andrew Ulmer, Esq. and Ian M. Bauer, Esq., PCVA Attorneys at Law, Tacoma, WA. Analysis of an arborist rope climbing device failure and free fall. (2024).
12. Wilson Jackson, Esq. & Elliotte Quinn, Esq., Steinberg Law Firm, LLC, Summerville, SC. Crushing death from an overhead crane. (2024).
13. Amelia Silver, Esq., Harding, Mazzotti, LLP, Manchester, VT. Analysis of a race car bumper jack and fatality. (2024).
14. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Analysis of a leveling ladder leg failure and subsequent fall of the climber. (2024).
15. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a ski lift failure and skier free fall from a lift chair. (2024).
16. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, SC. In-flight failure of the flight control mechanism on a two-seat monoplane. (2023).
17. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Injuries resulting from impact with a forklift moving rearward. (2023).
18. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Runover injury from a linear-move irrigation system. (2023).
19. Phillip Mazzotti, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Burning fuel emission from a tabletop pit, and associated burns. (2023)
20. Michael Edwards, Esq., Freeman Mathis & Gary, LLP, Las Vegas, NV. Alleged misuse of a water kettle available in a casino hotel room. (2023-present).

21. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Drowning death of a passenger riding on a water jet ski. (2023).
22. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Leg amputation from an intake conveyor for a saw mill board trimming operation. (2023).
23. Don Corson, Esq., Corson and Johnson Law Firm, Eugene, OR. Failure of a gooseneck trailer coupling. (2023).
24. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Evaluation of a fall involving a Little Giant Multipurpose Leveler Ladder. (2023).
25. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation from a collapsible basketball hoop and backboard structure. (2023).
26. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a failed garage door and lift, and resulting back injury. (2023).
27. Andrew Valentin, Esq., Schuster Law and Associates, Media, PA. ATV front end installation and failure. (2023).
28. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Zero turn mower misuse and rollover. (2023).
29. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation from an unguarded transport conveyor. (2023).
30. Brian Anderson, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a bicycle brake system failure and resulting injury from a downhill crash. (2023).
31. Michael Conley, Esq., Kenney & Conley, P.C., Braintree, Massachusetts. Tip over and injury from a wheeled dumpster. (2023).
32. Justine Bernstein, Esq., Schuster Law and Associates, Media, PA. Traffic cone distribution truck body structural failure and injury. (2023).
33. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation caused by a coating machine and roller nip. (2023).
34. Will Owen, Esq., Musselwhite, Musselwhite, Branch & Grantham, P.A., Lumberton, NC. Failure of a hydraulic powered fence post driver and resulting injuries. (2023).
35. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation of caused by a plastic shredder and air conveyor. (2023).
36. Greg Spizer, Esq. VSCP Law, Philadelphia, PA. Infant death in an inclined infant sleeping device. (2022-present).
37. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fall and injury from a failed scaffolding walkway. (2022-present).
38. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Hand and finger crushing in a baling machine used for plastic bale forming and wrapping. (2022-present).
39. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Fall from a climbing-type tree stand for hunting. (2023).
40. Terry McCarty, Reiner, Slaughter, McCartney, Frankel LLP., Rye, NY. Failure of a coffee percolator handle and resulting scalding injury. (2022-23).
41. Michael Trunk, Esq., Kline and Specter, PC. Philadelphia, PA. Class action suit against an infant inclined sleeper manufacturer (Kids 2, Inc.) related to multiple SIDS deaths – evaluation of the engineering design process used to develop the at-issue Kids 2, Inc. product. (2022-23).
42. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Hand crushing during the assembly of a pumping station using an overhead crane. (2022-present).
43. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Crushing incident and fatality from a failed robotic palletizer safety shutdown system. (2022-present).
44. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Respiratory disease from long term use of a failed PPE sandblasting suit and breather. (2022-present).
45. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fire and burns from an infant Pack and Play. (2022-present).
46. Mauro Ruiz, Esq., Ruiz Law Firm P.L.L.C., McAllen, TX. Failure of motorized hurricane exterior shutters and resulting death during a building fire. (2002-present)
47. Chad Shannon, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a bicycle brake system failure and resulting traffic injury. (2022-present).

48. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Entanglement death in a bulk de-baling machine used for plastic bottle recycling. (2022-present).
49. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Examination and analysis of effects of a water/soap mixture on a non-slip tile floor at a La Quinta hotel. (2022-present).
50. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Entanglement amputation in a defective screw conveyor caused by a failed lock out/tag out safety system and lack of engineering safety controls. (2022-present).
51. Kevin O'Brien, Esq., Sampone O'Brien Dilsheimer Law, Cheltenham, PA. Class action suit against an infant inclined sleeper manufacturer (Kids 2, Inc.) related to multiple SIDS deaths – evaluation of the engineering design process used to develop the at-issue Kids product. (2022-2024).
52. Carl Schiffman, Esq., Schiffman Firm, Pittsburgh, PA. Structural analysis of the failure of two small step ladders. (2022-2023).
53. Matt Dillon, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Injury from a right-angle grinder switch failure. (2022-present)
54. Ryan H Fisher, Esq., Lowe Scott Fisher Co LPA, Cleveland, OH. Slip out failure of an articulating ladder configured as an extension ladder. (2022).
55. Chad Shannon, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a portable ladder and scaffold structural failure and injury. (2022).
56. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Injury resulting from a powered multi-pallet pallet jack. (2022-present).
57. Miguel Dilley, Esq. Dilley Law Firm, San Antonio, TX. Child injury from a Walmart clothing rack collapse. (2022).
58. Robert Reardon, Esq. The Reardon Law Firm, P.C., New London, CT. Arm injury from a wire rope winding machine. (2021-present).
59. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Hand amputation by a commercial bag label printing machine. (2021-present)
60. Douglas Dilley, Esq. Dilley Law Firm, San Antonio, TX. Analysis of the frictional attributes, warnings, and injury associated with a wet tile floor fall at a McDonalds restaurant. (2021-2023).
61. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fatality caused by a fall from a concrete mixer truck. (2021-present).
62. Ian M. Bauer, Esq., Hagens, Berman, Sobol, Shapiro LLP, Seattle WA. Analysis of a rope climbing device failure and manufacturing and design defect. (2021-2022).
63. Brian Cox, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a crossbow structural failure and injury. (2021-present).
64. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Amputation by a Cabalas commercial meat grinder. (2021-present)
65. Ian Watt, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a leg amputation in a commercial saw mill. (2021-2022).
66. Terry McCarty, Esq., Reiner, Slaughter, McCartney & Frankel LLP., Rye, NY. Engineering analysis and testing of an articulated ladder slipout failure. (2021-2023)
67. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fatality from a stairs chair lift and battery charging system (2021-2022).
68. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Amputation caused by a concrete pump misstart. (2020-2022).
69. Raymond Gill, Esq., Gill and Chamas, LLC, Woodbridge, NJ. Portable charcoal grill structural failure and fatal fire. (2020-2023).
70. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Rotating cutter shroud failure on a wood chipper. (2020-present).
71. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Finger amputations caused by a stationary Porter Cable (Black and Decker) router. (2020).
72. Jason Schiffman, Esq., Schiffman Firm, Pittsburgh, PA. Kickback of a hand held Black and Decker circular saw. (2020-2022).
73. Aaron Parker, Esq., Law Offices of Peter G. Angelos, Baltimore, MD. Finger loss injury from a Black and Decker table saw. (2020-present).
74. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Plattsburgh, NY. Amputation from an unguarded mechanical drive train on a printing press. (2021-present)

75. John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. Examination and testing of an OTR tire change machine related to an operator fatality. (2019-2022).
76. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Assessment of ADA compliance of an outside ramp on South Padre Island, TX. (2019-2021).
77. Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. Analysis and testing of an articulated ladder, configured as an extension ladder, slip out injury. (2019-present).
78. John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. Refuse truck incident involving catastrophic injuries from flying debris. (2019-2022).
79. Wayne Marvel, Esq. Maron Marvel Bradley Anderson & Tardy LLC. Wilmington, DE. Examination and analysis of a fall injury with a Dewalt battery heated jacket. (2018-2022)
80. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. Hidalgo, TX. Examination and analysis of effects of water on a non-slip tile floor at a Lava Wash Laundromat. (2019-20).
81. Scott E. Schermerhorn, Esq. Law offices of Scott E. Schermerhorn. Scranton, PA. Analysis of an automotive lift collapse and crushing event. (2018-2020).
82. Miguel Dilley, Esq. Dilley Law Firm, San Antonio, TX. Analysis of a scaffold failure and OSHA-related jobsite violations. (2018).
83. James Thompson, Esq. Edelman and Thompson, LLC. Kansas City, MO. Structural failure of a fiberglass industrial stepladder. (2018-present).
84. Alberto Guerrero, Esq. Mask & Guerrero. McAllen, TX. Kinematics and kinetics of a Volvo tractor-trailer and car collision. (2018).
85. Jody Mask, Esq. Mask & Guerrero, Trial Attorneys. San Antonio, TX. Examination and design analysis of a failed fall arrester and fall arrest system. (2018).
86. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Analysis of a fiberglass crossbow structural failure and injury. (2018).
87. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the failure of a polymer spray applicator for coating fabrics. (2017).
88. Scott Kagan & Terry McCarty, Reiner, Slaughter, McCartney & Frankel LLP. Rye, NY. Evaluation and testing of a molded elastomeric foot on a multipurpose aluminum ladder. (2017-present).
89. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Railing failure and fall from a 5th story apartment porch. (2017-present)
90. Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Analysis of a low speed impact between two tractor trailers. (2017).
91. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a natural gas repair site and associated signage and traffic accident. (2017).
92. Linsey Scarcello, Esq., Langdon and Emison, LLC, Lexington, MO. Analysis of an articulating ladder molded foot design. (2017-18)
93. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a natural gas repair site and associated signage and traffic accident. (2017).
94. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a welding torch and failure and clothing fire. (2017).
95. Anthony Pinnie, Esq. Schuster Law and Associates, Media, PA. Failure of a polymer nut on a Pfister bathroom sink fixture. (2017)
96. Jody Mask, Esq., and Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. Donna, TX. Walkway trip and fall, and assessment of the American Disabilities Act design requirements. (2017)
97. Pete Friday, Esq., and Josh Licata, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a large elastomeric hose failure after post extrusion pressure testing. (2017).
98. Jody Mask, Esq., and Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Modeling of the kinetics of an impact between a John Deere backhoe and a pickup truck. (2017)
99. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the failure of a harness during the fall of worker cutting of a tree. (2016).
100. Chris Apessos Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a rear end collision involving a bumper hitch recreational trailer. (2016).
101. Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Forensic evaluation of a fall involving a mobile ladder. (2016-present)
102. Greg Nicosia, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an incident involving a Caterpillar Excavator. (2016).

103. Joshua Licata, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an electrocution involving a truck mounted aerial lift. (2016).
104. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Extremity laceration and equipment evaluation of a highschool wood shop tablesaw. (2015-17).
105. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Evaluation of a pallet jack foot crushing incident. (2015-present).
106. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a fall into a press for manufacturing tubing. (2015-17).
107. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Extremity loss evaluation from an automated chopsaw. (2015).
108. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a fall from a scissors lift (2015-present).
109. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a motorcycle ignition switch failure. (2015-present).
110. Amy Eddy, Esq. The Law office of Amy Eddy, PLLC. Kalispell, MT. Examination of a fiberglass extension ladder failure. (2015-16).
111. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Determining the impact characteristics of a rear truck bumper during a rear end collision. (2015-16).
112. Kevin Burger, Esq. Friday and Cox, LLC. Pittsburgh, PA. Analysis and testing of failed concrete reinforcement (rebar). (2015-2022).
113. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Determining the permeability characteristics of a crib bumper. (2015).
114. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a hunting stand structural failure. (2015-present).
115. Scott Kauff, Esq. Law Offices of John K. Dema, PC., St. Croix, Virgin Islands Analysis of a failed aluminum step ladder assembly. (2015-present).
116. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a failed clip for bicycle clip-in shoes. (2015-19).
117. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Examination of an ATV accident involving an unmarked electric pole guy wire. (2014-present)
118. Anthony Pinnie, Esq. Schuster Law and Associates, Media, PA. Examination of an electric cable transfer system at the Philadelphia Water Department's Receiving Station. (2014-present).
119. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an amputated arm accident by a horizontal boring machine. (2014-present).
120. Justin Bernstein, Esq. Pinnie Law Offices., Media, PA. Analysis of a smoke tunnel door latch system failure on a paper manufacturing system. (2014-2015).
121. James Navagh, Esq. The Law Office of John Wallace. Buffalo, NY Analysis of failed fiberglass ladder siderail. (2014 – present).
122. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a failed weld on a wood chipper jack. (2014-present)
123. Allan Freeman, Esq. Schultz Law LLC. Conshohocken, PA. Evaluation of a failed fiberglass step ladder. (2014-present).
124. David Cutt, Esq. Eisenberg, Gilchrist, and Cutt. Salt Lake City, UT. Analysis and testing of a failed aluminum step ladder. (2014 – present).
125. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a crushing head impact on an enclosed water slide stairs. (2014-present).
126. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an electrocution from overhead power lines. (2014-present).
127. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a powered rotating entrance door at a casino. (2013).
128. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the electrocution of a tree trimmer. (2013-present).
129. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Examination of a leg crushing accident involving a natural gas well beam pump. (2013-2015).
130. Bobby Kenny, Kenny Brothers, Inc. Bridgeville, DE. Analysis of a fractured GM diesel engine crank shaft. (2012).

131. Craig Hilborn, Esq., Hilborn & Hilborn, Birmingham, MI. Analysis of a step failure on a bucket truck fiberglass bucket. (2012-13)
132. Brantly White, Esq. Sico, White, Hoelscher, Braugh. Corpus Christi, TX. Analysis of an aluminum extension ladder failure. (2012-14).
133. David L. Jones, Esq., Jones Law Firm, P.L.L.C., Corpus Christi, TX. Analysis of an apartment heater temperature controller failure. (2011-12).
134. Gregory Hopper Esq., Salsbury, Clements, Bekman, Marder & Adkins, LLC. Analysis of a ladder failure. Baltimore, MD. (2011-12).
135. David L. Jones, Esq., Jones Law Firm, P.L.L.C., Corpus Christi, TX. Analysis of an extrusion machine design and accident. (2011-13).
136. David Kramer, Esq., Hilborn & Hilborn, Birmingham, MI. Analysis of failed fiberglass ladder siderail. (2011-14).
137. Kristen Sinisi, Esq., Angino and Associates, Harrisburg, PA. Analysis and testing of a failed aluminum stepladder. (2011-13)
138. Brett Farney, Esq., Farney Law Office, San Antonio, TX. Analysis of a failed aluminum step ladder side rail and first step. (2011-2012).
139. Joel Rosen, Esq. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Analysis of an oxygen cylinder failure and injury. (2011-12).
140. Cameron Davis, Esq., Hoversten, Johnson, Beckmann & Hovey, Austin, MN. Failure analysis of a failed aluminum extension ladder. (2011-13).
141. Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. Failure analysis of the structural failure of an articulating ladder. (2011-13).
142. John O'Connell, Esq., O'Connell and Associates, PC. Denver, CO. Analysis and testing of a failed aluminum telescoping extension ladder. (2010-12).
143. David J. DeToffol, Esq. DeToffol & Associates Attorneys at Law. New York, NY. Failure analysis of the locking pin on a telescoping extension ladder. (2010-12).
144. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Stress analysis and testing of a Grade A, class 2 shackle failure and injury. (2010-12).
145. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Analysis and testing of a Schedule 160 high pressure pipe fitting failure and fatality. (2010-12).
146. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Georgia buggy accident and operator injury investigation. (2010-present).
147. Thomas J. Gilbride, Esq. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of an aluminum scaffold jack. (2010).
148. Kiersta D. Perlee, Esq., The Arnold Law Firm, Sacramento, CA. Structural analysis of a failed fiberglass channel. (2010).
149. Tom Power, Esq. Power, Rogers & Smith, P.C., Chicago, IL. Examination of a failed rubber foot. (2010-present).
150. Peter Friday, Esq. Friday, Porta, Cox, and Ward, LLC. Pittsburgh, PA. Evaluation of the swimming pool electrocution. (2010).
151. Jeff Clark, Esq., Schmittinger & Rodriguez, Dover, DE. Analysis and testing of a pultruded fiberglass structural failure. (2010-12).
152. Eugene McGurk, Esq., Raynes McCarty, Philadelphia, PA. Analysis of the structural failure of a carbon fiber bicycle frame. (2010-2012).
153. Christina T. Novajosky, Esq. O'Malley & Langan, P.C., Scranton, PA. Analysis of a foot pad failure and overall stability of an aluminum step ladder. (2010).
154. Tim Lengkeek, Esq., Young, Conaway, Stargatt, & Taylor, LLP, Wilmington, DE. Analysis of an accident involving a conveying system. (2009).
155. Junie Sinson, Esq, Sinson & Sinson, LTD, Chicago, IL. Analysis of a ladder side rail structural failure. (2009-present).
156. Devon Bruce, Esq., Power, Rogers & Smith, P.C., Chicago, IL. Examination of a fiberglass side rail failure. (2009).
157. A.J. Sackett & Sons, Inc., Baltimore, MD. Review of a load out conveyor and blending system design and accident. (2009).
158. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis of the electro-hydraulic system design and failure for a trailer boom lift accident. (2009). – just papers

159. Lauren Hudecki, Esq., Young, Conaway, Stargatt, & Taylor, LLP, Wilmington, DE. Analysis of an accident involving a hydraulically driven screening machine (2009).
160. Wyatt Stevens, Esq., Roberts & Stevens, P.A., Asheville, N.C. Testing and analysis of a high performance carbon fiber water ski failure. (2009).
161. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Analysis of an aluminum step ladder failure. (2009).
162. Peter Friday, Friday, Porta, Cox, and Ward, LLC. Pittsburgh, PA. Analysis and testing of a horizontal mixing mill safety shutdown system. (2009).
163. John Roberts, Esq., Ball, Hulbert and Roberts. Analysis of a fiberglass step ladder failure. Pasadena, CA (2008).
164. The Dalton Law Firm, Wilmington, DE. Structural analysis and property testing of aluminum step ladder (2007-2008).
165. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis and testing of a defective cast aluminum motorcycle wheel. (2007-08).
166. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of a portable steel ladder failure and accident. (2006)
167. Craig D. Brown, Esq., Foote, Meyers, Mielke & Flowers, Geneva, Illinois. Analysis of a spreader bar failure on a step ladder. (2006-07).
168. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis and testing of a fiber reinforced composite cut-off wheel for abrasive metal cutting (2006-2008).
169. The Walker Law Group, Clearwater, FL., Analysis of fiberglass step ladder failure (2006-present).
170. Richard South, Esq., Wright and Greenhill, P.C., Austin TX., Analysis and testing of an articulating ladder failure. (2006-09).
171. Joel Rosen, Esq. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Analysis of a snap blade knife failure and accident. (2006-09).
172. Welebir & McCune, Redlands, California. Failure analysis of a fiberglass step ladder. (2006-08).
173. Mary Buonanno, Esq., Attorney-at-Law, Takoma Park, MD. Failure analysis of a composite extension ladder siderail. (2006-08).
174. Danny Henderson, Esq., Peters, Murdaugh, Parker, Eltzroth & Detrick Law Offices, Hampton, SC. Failure analysis of an aluminum step stool. (2006-09).
175. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Preliminary analysis of a window failure. (2006-07).
176. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Evaluation of the safety shutdown system on a concrete power trowel (2006).
177. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Structural analysis and testing of an extension ladder. (2006).
178. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis of a forklift brake failure. (2006).
179. Edgar Snyder and Associates, Pittsburgh, PA. Analysis and ASTM testing of the structural failure of a polyethylene molded chair. (2006).
180. Edgar Snyder and Associates, Pittsburgh, PA. Analysis of the structural failure of a composite bike fork. (2006).
181. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of a step stool accident. (2006)
182. Ronald Owen, Attorney at Law, Jacksonville, FL. Failure analysis of a fiberglass extension ladder. (2004-present).
183. O'Malley & Langan, P.C., Scranton, PA. Biomechanics of the impact of a clevis pin on the human skull and neck fitted with a hardhat. (2004-present).
184. Todd S. Miller and Associates, Allentown, PA. Evaluation of a brake failure on a hydrostatic drive, self-propelled asphalt paver. (2004-05).
185. Ferrara, Rossetti & DeVoto, P.A., Cherry Hill, NJ. Preliminary failure analysis of the power train on a shaft-drive motorcycle. (2004).
186. O'Malley & Langan, P.C., Scranton, PA. Analysis of a motorcycle steering column failure and accident. (2004-present)
187. Peter Friday, Esq., Woomer and Friday, Attorneys at Law, LLP, Pittsburg, PA. Analysis and testing of a horizontal mixing mill accident. (2003-05).
188. Todd O'Malley, Esq., O'Malley & Langan, P.C., Scranton, PA. Analysis of an automotive jackstand failure. (2003-07).

189. Leavis and Rests, P.C., Boston, MA. Analysis and experimental evaluation of a defective childs toy. (2003-07).
190. Crews and Bodiford, P.A., Orlando, FL. Failure analysis and testing of a composite sandwich structure water ski. (2003-06).
191. Leavis and Rests, P.C., Boston, MA. Failure analysis of an aluminum extension ladder siderail. (2003-06).
192. Gibson, Valenti & Ashley, P.A., Lake Wales, FL. Rivet pullout analysis of a fiber reinforced structure. (2003-05).
193. Smith, Phillips, Mitchell and Scott, Hernando, MS. Failure analysis of an aluminum open channel. (2003-05).
194. Robert M. N. Palmer, P.C., Springfield, MS. Failure analysis of an aluminum step ladder. (2003-05).
195. Frankel, Cunningham, Stambaugh & Associates, York, PA. Failure of an aluminum extension ladder. (2003-05).
196. Hardin, Kundla, McKeon, Poletto & Polifroni, Springfield, NJ. Fiberglass side rail structural analysis and testing for a failed Werner step ladder. (2003-05).
197. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Structural analysis and testing of an aluminum folding walker. (2003).
198. Hourigan, Kluger, and Quinn, Kingston, PA. Failure analysis of an aluminum step ladder. (2002-03).
199. The Krasnow Law Firm, Roanoke, VA. Failure analysis of a fiber-reinforced step ladder. (2002-03).
200. Smith, Stephens, Reed & Phillips, Inc., Pittsburgh, PA. Evaluation/testing of the safety shutdown system on a horizontal mixing mill. (2002).
201. Litvin, Blumberg, Matusow, and Young, Philadelphia, PA. Evaluation/testing of the crushing potential of a vehicle power seat with position memory. (2002-03).
202. Venable, Baetjer, Howard & Civiletti, LLP, Washington, D.C. Failure analysis and testing of an exercise device. (2002).
203. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Failure analysis of a vending machine fan motor. (2002).
204. Scanlon and Co., LLC, Akron, OH. Failure analysis of an aluminum step ladder. (2002).
205. Universal Underwriters Group, Overland Park, KS. Product liability design evaluation. (2002).
206. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Assessment of the design, and testing of a concrete chop saw. (2001).
207. Structural Mechanics Associates, Inc., Philadelphia, PA. Various stress analysis projects for extruded aluminum and fiber-reinforced structures. (1999-2019).
208. National Forensic Engineers, Inc., Pittsburgh, PA. Various failure analysis of step ladders accident cases. (1999-2005).

- Professional Engineering Mechanical Design Services - *Industry and Government*
  1. Mid-Atlantic Organic Resource Recovery Company, Ridgley, MD. Design of a large circular rotating composting vessel and drive for composting poultry renderings. (2023-24).
  2. Fifer Orchards, LLC, Wyoming, DE. Design of a high capacity durable sweep for sweet corn distribution to the packing line workers. (2023).
  3. Fennimore Construction, Inc., Clayton, DE. Floor joist sizing and footer requirements for a porch addition to an existing home. (2023).
  4. L&L Farms, Inc., Townsend, DE. Structural damage caused by the ridged mounting of a screw-type conveyor to the top of a grain bin. (2023).
  5. Siemens Healthcare Diagnostics, Glasgow, DE. Measurement of hand squeeze force and load to failure for a new bottle cap design with reduced geometric features to lower stress concentrations and increase cap strength. (2022).
  6. Siemens Healthcare Diagnostics, Glasgow, DE. Design validation and testing of a new bottle cap closure for medical grade bleach compatibility. (2021-22).
  7. Fifer Orchards, LLC, Wyoming, DE. Design and installation of a sweet corn truck unloading system for bulk fresh market produce. (2021).
  8. Siemens Healthcare Diagnostics, Glasgow, DE. Testing to determine the causes of leaks in injection molded cuvettes. (2020).
  9. EZ Venture, LLC, Harrington, DE. Design of an ethanol-based extraction process and facility for the processing of CBD hemp oil. (2019-21).
  10. Fennimore Construction, Clayton, DE. Beam sizing for a home renovation. (2019).
  11. Siemens Healthcare Diagnostics, Glasgow, DE. Testing to determine the degradation of polyethylene bottle caps when saturated with chloride bleach. (2019-present).

12. Duffield Associates, Wilmington, DE. Renovation plan for the New Castle County (DE) wastewater treatment facility (2019-present).
13. Siemens Healthcare Diagnostics, Glasgow, DE. Redesign of a click-lock cap for medical instrument reagents. (2019-21).
14. Siemens Healthcare Diagnostics, Glasgow, DE. Bottle sorting mechanism to prevent mechanical damage and bottle leakage. (2019-20).
15. Siemens Healthcare Diagnostics, Glasgow, DE. Load and leak testing of analytical instrument cuvettes for human fluid and reagent transport. (2018).
16. Fennimore Construction, Clayton, DE. Structural analysis of several balconies at the Bayview Development. (2018-2019).
17. Siemens Healthcare Diagnostics. Glasgow, DE. Measurement of insertion force of an injection molded insert into a regent bottle. (2017).
18. The Dupont Co., Wilmington Experimental Station, Wilmington, DE. Development of an automated XY table for rapid carbon fiber fabric formation for near net shape structural automotive components. (2016-17).
19. The Town of Middletown, Delaware. Middletown, DE. Development of a bidding and selection process for the remediation of the town-owned agricultural fields. (2014, 2016, 2018)
20. Siemens Healthcare Diagnostics. Glasgow, DE. Fatigue analysis, and mechanical and chemical testing of injection molding tooling. (2016-17).
21. Siemens Healthcare Diagnostics. Glasgow, DE. Automated torqueing of bottle lids for analytical instrument reagents. (2016-17).
22. The Town of Middletown, Delaware. Middletown, DE. Development of 150 acre sports complex utilizing treated municipal wastewater for irrigation. (2015-2017)
23. Mid Atlantic Industrial Belting, Newark, DE. Analysis of a flat belt failure. (2015).
24. ATK (Alliant Techsystems, formerly Thiokol), Elkton, MD. Analysis of a fiberglass structural failure and recommendations for an improved safety inspection procedure. (2014).
25. Dr. Peter Popper, Wilmington, DE. Modeling the needle tip spatial location during tumor sample extraction. (2013)
26. The Town of Middletown, Delaware. Middletown, DE. Calculation of field loading rates resulting from Copper Sulfate algae treatment in the wastewater lagoons. (2013)
27. Kraft Foods, Dover, DE. Design of and engineering drawing for a servo motor mount. (2013)
28. New Castle County, DE. Odessa, DE. Calculation of the assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater for the Odessa area fields. (2012)
29. The Town of Middletown, Delaware. Middletown, DE. Calculation assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater for the Burger farm. (2012)
30. Siemens Healthcare Diagnostics. Glasgow, DE. Elastic property measurement of a multi-laminant polymer film for medical applications. (2012).
31. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended permit application to expand spray-on-demand in the Middletown region. (2012)
32. Tornier, Inc. Edina, MN. Consolidation characteristics of several biomedical laminates. (2011-12).
33. The Town of Middletown, Delaware. Middletown, DE. Development and supervision of a bid process for the remediation of the dedicated spray irrigation fields used for wastewater disposal. (2011-12)
34. Siemens Healthcare Diagnostics, Glasgow, DE. Analysis of an HDPE injection molded component failure. (2011).
35. Tornier, Inc. Edina, MN. Development of a manufacturing process to consolidate and compress biomedical fabrics. (2010-2011).
36. Tornier, Inc. Edina, MN. Development of a machine vision system to quantify porosity of biomedical fabrics. (2010-2011).
37. University of Delaware, College of Engineering. Newark, DE. Load rating computation, engineering drawings and load rating label recommendations for two lift structures in the College of Engineering Machine Shop. Newark, DE (2010).
38. The Town of Odessa, Delaware. Odessa, DE. Calculation assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater. (2010)
39. Kraft Foods Inc., Dover, DE. Fastener strength requirements for an overhead crane system. (2009).
40. Consumer Union, Yonkers, NY. Evaluation of vibrating exercise machines. (2006-07).
41. Cirrus Engineering, Delaware Technology Park, Newark, DE. Measurement of cutting force dynamics for several PTFE coated microtome histologist blades. (2006-2011).

42. Institute for Energy Conversion, Newark, DE. Design and implementation of a self-tuning controller for a multi-chemical batch reactor with web handling for thin film photovoltaic manufacturing. (2003-2005).
43. Hard Hat, LCC, Baltimore, MD. Design and computer-aided-drafting of a hand-struck tool product line for overseas production. (2003).
44. George Whitmyre, Newark DE. Design of and engineering drawings for a welded steel bracket w/ compound angles. (2003).
45. Baltimore Tool Works, Inc., Baltimore, MD. Programmable Logic Controller (PLC) programming. (2002).
46. Cirrus Engineering, Inc., Wilmington, DE. Characterization of edge geometry for coated microtone knives; Estimation of cutting energy for apparel fabric and the design and automation of fabric cutting equipment. (2002-03).
47. Monsanto Co., Inc., Galena, MD. Design/Development of a pneumatic conveying system for hybrid seed. (2001-02).
48. Monsanto Co., Inc., Galena, MD. Calculation of the load capacity of a storage loft. (1999).

OUTREACH

PEER-REVIEWED EXTENSION PUBLICATIONS

1. Kee, W.E., J.L. Glancey, and T.L. Wootten. 2004. Successful lima bean production in Delaware: A management profile. Extension Bulletin VF-6. University of Delaware, Newark, DE.
2. Kee, W.E, K. Everts, J.L. Glancey, and T.L. Wootten. 2004. Pea production in Delaware. Extension Bulletin VF-4. University of Delaware, Newark, DE.

Glancey, J.L. 2001. Equipment for effective poultry litter management. Delaware Nutrient Management Notes. 2 (1): 1-3.

NON-REFEREED EXTENSION PUBLICATIONS & REPORTS

1. Stoops, A. and J. Glancey. 2010. Drip irrigation basics. Handout for the 2010 Twilight New Castle Growers Meeting, Newark, DE.
2. Glancey, J. 2008. Facility housing considerations for Delaware dairy farms. Proceedings of the 2008 Delmarva Dairy Day, Harrington, DE
3. Glancey, J. 2007. Mechanical sidedressing: Is there an opportunity with some horticultural crops? Proceedings of the 2007 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
4. Glancey, J. 2007. Adjustment and operation of conditioning equipment for increased drying rates and decreased dry matter losses. Proceedings of the Southern and Central Maryland Hay and Pasture Conference, Waldorf, MD.
5. Glancey, J. 2006. Mechanical harvest characteristics of several small greens. 2006. Proceedings of the 2006 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
6. Glancey, J. 2005. Performance and safety concerns with the new bandsaw-type spinach harvester. 2005. Proceedings of the 2005 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
7. Glancey, J. 2000. Flow rate requirements for center pivot irrigation systems. 2000.
8. Glancey, J. and E. Kee. 1999. Report on the throughput capacities and recovery characteristics of tractor mounted and pull-type cucumber harvesters.
9. Kee, E. and J. Glancey. 1997. Harvest loss in peas and lima beans with pod stripper combines.
10. Kee, E., T. Wootten, and J. Glancey. University of Delaware Pea Variety Trials. 1996, 1997, 1998, 2000, 2002.

PRESENTATIONS & DEMONSTRATIONS AT COOPERATIVE EXTENSION AND OTHER OUTREACH MEETINGS

1. Multiple Updates on the Delmarva N and P mass balance as part of the Land and Litter Challenge. (2017). L&L Steering Committee Meeting, Wye, MD.
2. Irrigating Agricultural Crops with Treated Municipal Wastewater: Review of a Three Year Study and New Regulations in Delaware. 2014. STAC meeting of the Center for the Inland Bays, Lewes, DE.
3. Latest in baler technology and bale size economics. 2014. Delaware Ag Week, Harrington, DE.
4. Updates on the next version of the EPA model to predict nutrient loading in the Chesapeake Bay from the poultry industry. 2014. Delaware Ag Week, Harrington, DE.
5. Latest in baler technology and bale size economics. 2014. Southern Maryland Hay & Pasture Conference, Brandywine, MD.
6. Moisture sensing technologies for hay production. 2013. Delaware Ag Week, Harrington, DE.
7. Recommendations for the Reuse of Treated Municipal Wastewater for Irrigating Crops. 2013. 2013 Mid-Atlantic Crop Management School, Ocean City, MD.
8. Moisture sensing technologies for hay production. 2013. Southern Maryland Hay & Pasture Conference, Brandywine, MD.

9. Moisture sensing technologies for hay production. 2013. Tri-State Hay & Pasture Conference, Oakland, MD.
10. Environmental pressures on small vegetable processors- a case study for lima bean grading. 2013 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
11. As Needed Irrigation with Municipal Wastewater: A Pilot Project for the Town of Middletown. 2012. Delaware Ag Week, Harrington, DE.
12. Irrigating with Highly Treated Municipal Wastewater: Feasibility for Vegetables? 2012 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
13. Drip irrigation basics demonstration. 2010. Twilight meeting for New Castle County growers. (with Anna Stoops, Extension Agriculture Agent).
14. Moderator of a grower and dealer panel—Irrigation Engineering Advances and Water Conservation. 2010. Irrigation Session, Delaware Ag Week, Harrington, DE.
15. Season extenders: row covers, greenhouses, high and low tunnels and cold frames. 2010. Delaware Organic food and Farming Association Annual Educational Meeting. Dover, DE.
16. Compaction in processing vegetable fields: causes and cures. 2009. Delaware Ag Week, Harrington, DE.
17. Technologies for Manure Management. 2009 Delmarva Dairy Day. Hartley, DE.
18. Energy efficiency of alternative fuels and tips for saving energy on the farm. 2008. Agronomy/Soybean Session, Delaware Ag Week, Harrington, DE.
19. Nutrient management considerations for various tillage systems. 2008. Nutrient Management Session, Delaware Ag Week, Harrington, DE.
20. Facility considerations for Delaware dairy farms. 2008 Delmarva Dairy Day, Harrington, DE
21. Panel member: Discussion on cover crops, irrigation, tillage practices and nutrient management. 2008 Delmarva Dairy Day, Harrington, DE
22. Machine setup and operation for optimal quality forage. 2007. The 2007 Mid-Atlantic Crop Management School, Ocean City, MD.
23. GPS and precision agriculture applications for agronomic and vegetable crops grown in the Delmarva region. 2007. The Southern States Cooperative Growmaster Annual Training Program, Harrington, DE.
24. Composite-based tool designs to reduce vibration and noise. 2007. The Delaware Woodworkers Guild Meeting, Glasgow, DE.
25. Maintenance, adjustment, and operation of mower-conditioners to minimize drying time and dry matter losses in hay production. 2007. Southern and Central Maryland Hay and Pasture Conference. Waldorf, MD.
26. Harvest recovery of a band saw cutter for spinach and several small greens. 2007 Delaware Ag Week, Harrington, DE.
27. Maintenance, adjustment, and operation of mower-conditioners to minimize drying time and dry matter losses in hay production, 2007 Delaware Ag Week (both day and night programs), Harrington, DE.
28. Performance and recovery characteristics of a band saw cutter for spinach and several small greens. 2006 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
29. Design of a continuous blade cutter for processing spinach. 2006. Delaware Ag Week, Harrington, DE.
30. GPS contest. 2005 Day on the Farm, Hockessin, DE.
31. Design and safety concerns with the new bandsaw-type spinach harvester. 2005 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
32. How to use GPS waypoints to identify and find hidden objects. 2004 Day on the Farm, Middletown, DE.
33. Biodiesel: Facts and fiction. 2004. 2004 Agronomy Days. Delaware Cooperative Extension. Harrington, DE.
34. Update on commercialization of bio-based fuels and lubricates & considerations for road and off-road vehicles. 2004. Delaware Vegetable Growers Association, Harrington, DE.
35. Application machinery and technology considerations for cost-effective nutrient management. 2004. The 2004 Mid-Atlantic Crop Management School, Ocean City, MD.
36. GPS technology demonstration and GPS challenge contest. 2003. Farm and Home Field Day, Georgetown, DE.
37. How to choose, use and not abuse hydraulic systems and fluids. 2003. Delaware Agronomy and Machinery Day, Harrington, DE
38. Design and development of detachable cutter knives for high speed disc cutter bars. 2002. Delaware Vegetable Growers Association (with Dawn Cintavey, W.L. Gore and Associates, Inc.), Harrington, DE.
39. Yield monitoring and precision field mapping in vegetable crops. 2001. Delaware Vegetable Growers Meeting, Felton, DE 2001.
40. Current and future trends in intelligent agricultural machinery, 2001. Delaware Agronomy Day, Harrington, DE.
41. Irrigation system design for the Mid-Atlantic region. 2000. University of Maryland Cooperative Extension Service Winter Growers Meeting. Fair Hill, MD.

42. Yield monitors and new harvesting equipment for processed vegetable production. 2000. The 2000 Mid-Atlantic Crop Management School, Ocean City, MD.
43. Center pivot irrigation system design and economic considerations for Delaware. 1999. Delaware Cooperative Extension Service New Castle County Growers Breakfast Meeting. 1999. St. Georges, DE.
44. Prototype device for sensing watermelon ripeness. Farm and Home Field Day. 1999. Georgetown, DE.
45. Update on Cucumber Harvesting Research. 1999. University of Delaware Grower and Processor Pickling Cucumber Meeting. Georgetown, DE.
46. What's driving precision agriculture in Delaware? 1998. University of Delaware In-Service for Cooperative Extension Professionals. Dover, DE.
47. Irrigation pumping methods and equipment for improved water management. 1998. University of Maryland Cooperative Extension Kent Co. Growers Meeting, Galena, MD.
48. New equipment for irrigation and water resources management. 1998. University of Maryland Wye Research Center, Wye Mills, MD.
49. New technology for vegetable production. Delaware Vegetable Growers Meeting. 1998. Milford, DE.
50. Comparison of the new shaker harvester to conventional harvesters for processed cucumbers. Delaware Vegetable Growers Meeting. 1998. Milford, DE.
51. New technology for irrigation and water management. 1998. Mid-Atlantic Crop Certification School, Dover, DE.
52. Demonstration of a precision manure applicator. 1997. DNREC Crop Management Tour, Sussex County, DE.
53. Techniques for reducing tire-induced soil compaction. 1997. Delaware Vegetable Growers Meeting. Milford, DE.
54. Progress in developing yield monitors for processed vegetables. 1997. Delaware Vegetable Growers Meeting. Milford, DE.
55. Reducing the potential for soil compaction induced with pneumatic tires. 1997. Milford Fertilizer Inc. Annual Field Crops Growers Meeting, Bordentown, NJ.

DELAWARE COOPERATIVE EXTENSION ENGINEERING SERVICES PROJECTS

1. Design of a Tractor Trailer Unloading System for Sweet Corn. Fifer Orchards, Wyoming, DE. (2020-21).
2. Measurement of potato emergence and population in a commercial potato production setting. Pries Farm, Harrington, DE. (2019)
3. Implementation of reclaimed wastewater program at the new Milton, DE wastewater treatment facility for on-demand agricultural irrigation. Artisan Water Co., Inc. (2019-present).
4. The Town of Middletown, Delaware. Middletown, DE. Proposal to Governor Carney and Secretary Garvin (DNREC) for a state-wide review and revision of the regulations governing the treatment and distribution of wastewater in Delaware. (2018-present).
5. The Covered Bridge Inn, Lewes, DE. Design of a radiant infrared heating system for an agricultural barn and reception facility for a wedding venue. (Hopkins Dairy Farm). (2017).
6. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended CMR permit application to recognize agricultural spray-on-demand irrigation as dedicated wastewater disposal capacity in the Middletown region. (2017-18).
7. Puglusi Egg Farm, Middletown, DE. Modifications to the washwater disposal system to achieve compliance with the DNREC operating permit. (2015-16).
8. Howard Webb Farm, Lincoln, DE. Design of a ventilation system and electrical service for a beef holding and finishing building. (2016).
9. Kraft Foods, Inc., Dover, DE. Forensic analysis of high rate of failures on the StoveTop Stuffing manufacturing line. (2013).
10. Kraft Foods, Inc., Dover, DE. Re-design of the drive system for package handling. (2013).
11. New Castle County Wastewater Treatment Division. New Castle, DE. Feasibility calculations for the distribution of highly treated wastewater to the farms surrounding Waterfarm #1 in Odessa. (2013)
12. Delaware Electric Coop. Greenwood, DE. Pollution and energy implications of converting Tier 1, 2, and 3 diesel irrigation pump engines to electric motors. (2013).
13. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended permit application to expand spray-on-demand in the Middletown region. (2012-14).
14. Duffield and Associates, Pike Creek, DE. Calculation of Ag BMP's nutrient savings for the purpose of nutrient credit trading (2013).
15. The Town of Middletown, Delaware. Middletown, DE. Development and supervision of a bid process for the compaction remediation and re-seeding of the dedicated spray irrigation fields used for wastewater disposal. (2012)
16. Delaware Electric Coop. Greenwood, DE. Computation of PM and NOx emissions from all stationary generators. (2012).

17. Dogfish Head Brewery, Milton, DE. Design of a processing facility to extract juices from local produce as ingredients for beer. (2012-13).
18. Fifer Orchards, Wyoming, DE. Redesign of a sweetcorn packing line for a crew size of 50 packers. (2012-15).
19. The Town of Middletown, Delaware. Middletown, DE. Review of the soil and irrigation management program at the Frog Hollow Golf Course. (2012)
20. West Farms, Milford, DE. Modification of a grading station and development of an amended permit application for DNREC compliance. (2011-14).
21. Delaware Department of Transportation (DelDOT), Georgetown, DE. Design analysis of the hydrostatic drive propulsion system and thruster shaft sealing system on the Delaware Woodland Ferry. (2011-13)
22. Austin & Bednash, Newark, DE. Analysis of the head loss in a dry fire hydrant line & sizing of a primer pump for the hydrant. (2011).
23. Kraft Foods, Inc., Dover, DE. Re-design of the liquid ingredient pumping system for bulk shaved coconut manufacturing. (2011-12).
24. Delaware Department of Transportation (DelDOT), Georgetown, DE. Diagnosis of the misalignment on the loading ramp and redesign of the ramp lifting linkage on the Delaware Woodland Ferry. (2011-12).
25. Artesian Water Company, Inc. Christiana, DE. Nutrient loading limits and water demand for spray on demand irrigation with treated municipal wastewater from Rehoboth Beach, DE. (2011)
26. Delaware Refining Company, LLC., Delaware City, DE. 2011. Feasibility analysis for an ethanol processing facility and a biodiesel processing facility at the Delaware City Refinery. (2011)
27. Aerca Advisors, Wilmington, DE and the Delaware Department of Agriculture, Dover, DE. Development of a power purchase agreement (PPA) between the State of Delaware and a corporation in Delaware. (2011).
28. Chesapeake Utilities, Dover, DE. Feasibility of using natural gas as a replacement for propane for heating poultry houses. (w/ Bill Brown). (2011-12)
29. Lally White, LLP, Lewes, DE & the Delaware Department of Agriculture, Dover, DE. Development of an online knowledge base for the evaluation of solar power systems for agribusinesses. (2011-12)
30. Rolland Hitchens, Georgetown, DE. Calculation of structural member sizes to support extended ballasting weights. (2011).
31. Artesian Water Company, Inc. Christiana, DE. Nutrient loading limits and water demand for spray on demand irrigation with treated municipal wastewater from Rehoboth Beach, DE. (2011)
32. Port of Wilmington, Wilmington, DE. Design recommendations for a 2000 heifer short-term holding facility for loading overseas transportation vessels. (2010-2012)
33. ARCA Advisors and Mid-Atlantic Renewable Parnters LLC (MARP). Feasibility study for large (multi-acre) photovoltaic systems at Perdue (Milford), Mountaire (Millsboro), Vlasic (Millsboro), and Allen's Family Foods (Harbeson). 2010-12.
34. West Farms, Milford, DE. Design of new manufacturing processes and hardware for separating green and white lima beans that reduce Sodium and Chloride concentrations in the wastewater distributed to wastewater spray irrigation systems. (2010-present).
35. Town of Middletown, DE. Drafting of a long-term contract between the growers and town for the use of treated municipal waste water for the irrigation of agricultural crops. (2010-11).
36. Fifer Orchards, Wyoming, DE. Preliminary kWh production estimate and design for a low head turbine-based electrical generation system and dam redesign for the Wyoming pond. (2010-11).
37. L & L Farms, Townsend, DE. Drafting of a lease agreement for renting land for as-needed spray irrigation of agricultural crops with treated and filtered municipal wastewater. (with Anna Stoops, Extension Agriculture Agent). (2010-present)
38. Delaware Department of Agriculture, Dover, DE. 2010. Preliminary sizing for a PV system for the Dover State office. (2010).
39. Coleman's Christmas Tree Farm, Odessa, DE. A Day on the Farm 2010. Promoting agriculture in the state of Delaware –recommendations of land use planning and event volunteer. (2010).
40. Town of Middletown, DE. Recommendations for remediating compaction in dedicated spray irrigation fields owned by municipalities (w/ Anna Stoops, Ext. Ag. Agent). (2010-present)
41. Kranz Farm, Newark, DE. Design of a drip tape or drip emitter system for vegetable production. (with Anna Stoops, Extension Agriculture Agent). (2010).
42. Fifer Orchards, Wyoming, DE. Reconfiguration of a fresh market sweet corn packing line to increase throughput. (2010).
43. Town of Middletown & Artesian Water, Middletown DE. Recommendations for using treated wastewater effluent to irrigate agricultural crops. (2009-present).

44. Delaware Department of Agriculture, Dover, DE. 2010. PV system design and costing for the Redden State Facility in Georgetown, DE.
45. Howard Webb, Milford, DE. Design and configuration of a slatted floor beef facility. (2009)
46. Vogl Farms, Harrington, DE. Design of a structure for a new young animal housing. (2008-09).
47. Carlisle Farms, Greenwood, DE. Design and fabrication of steel drive pulleys for band saw type greens cutters. (2008).
48. Fifer Orchards, Wyoming, DE. Redesign of the hydrocooler water pumping and cleaning systems to reduce heat exchanger fouling. (2008).
49. Seaford High School. Structural analysis and wind load certification of a non-engineered greenhouse. (2008).
50. Rolland Hitchens & Hannover Foods Corp, Georgetown, DE. Configuration, calibration, emergence measurements of a grain drill for narrow row, no-till lima bean production. (2008).
51. Fifer Orchards, Wyoming, DE. Design and implementation of processing line modifications to reduce peach and apple fruit bruising during handling and packing. (2007).
52. Blair View Aquaculture Farm and the NRCES. Milford, DE. Design and implementation of a powered, closed-system, rotary drum composter for tilapia mortalities. (2007)
53. Kenny Grading Station, Bridgeville, DE. Paper design of an on-site relish fermentation system – heater sizing and estimate of energy requirements and costs. (2006)
54. H&S DuBoise, Pittgrove, NJ. Design of and recovery measurements for a continuous cutter for small greens. (2006).
55. Blair View Aquaculture Farm, Milford, DE. Design and implementation of a catch-and-weigh system for tilapia harvest. (2005-06).
56. Kenny Grading Station, Bridgeville, DE. Design and installation of a speed reduction drive for a high volume pumping station. (2005).
57. Colemans Tree Farm, Odessa, DE. Irrigation pump and electric motor selection. (2005).
58. Carlisle Farms, Greenwood DE. Installation of a continuous blade spinach cutter header on a Portaway harvester. (2004).
59. Mumford General Contractors, Seaford, DE. Testing protocol for the evaluation of a defective concrete floor. (2004).
60. Carrazza Farms, Townsend, DE. Estimation of fuel consumption for stationary power units for oxygenator recommendations on diesel power units in Delaware. (2004).
61. Blair View Aquaculture Farm, Milford, DE. Design and fabrication of a basket conveyor for live tilapia harvest and loading. (2004-05).
62. Kenny Grading Station, Bridgeville, DE. Finite element analysis and installation of a continuous, long-span, beam-type water line and support structure for the hydro-unloading of cucumber transport trucks. (2004).
63. Woodenhawk Farms, Greenwood, DE. Structural analysis and engineering certification of a greenhouse structure. (2003).
64. L&L Farms, Inc., Middletown, DE. Field measurements and analysis of multiple center pivot irrigation system structural failures. (2001).
65. Gundry Greenhouses, Laurel, DE. Structural analysis and engineering certification of a hoop greenhouse structure. (2000).
66. Richardson's Farm, Hurlock, MD. Design of bridges over drainage ditches for center pivot irrigation systems. (2000).
67. Hitchens Farms, Inc. Georgetown, DE. Field evaluation of an irrigation system end gun reconfiguration for lawsuit settlement. (1999).
68. Carlisle Brothers, Inc., Greenwood, DE. Selection and installation of a fuel flow meter for irrigation system power units. (1999).
69. Holy Hill Farms, Milford, DE. Hydraulic system redesign and installation for a raven cucumber harvester. (1998).
70. Fifer Orchards, Wyoming, DE. Design and setup of a sweet corn grading & packing line with a hydrocooler. (1998-99).
71. Fifer Orchards, Wyoming, DE. Design and setup of a hydraulic drive and unloading system for sweet corn wagons. (1997).
72. Jersey Asparagus Farms, Elmer, NJ. Design and testing of shaker cleaning system for asparagus root crowns. (1997-98).

SERVICE

GOVERNMENT SERVICE

- *Gubernatorial Appointment,* Delaware's Representative on the EPA's Scientific and Technical Advisory Committee (STAC) for the Chesapeake Bay Program. 2011-2014 term.
- *Invited Panel Member,* Congressional Delegations of Delaware and Maryland's Environmental Summit. 2012.
- *Cabinet Secretaries (DNREC & DDA) Appointment,* State Certainty Committee and Program, State of Delaware. 2012-present.
- *Invited Panel Member,* Congressional Delegations of Delaware and Maryland's Environmental Poultry Summit. 2012.
- *Gubernatorial Appointment,* Governor's Energy Advisory Council, State of Delaware. 2009-2012 term.
- *Cabinet Secretaries (DNREC & DDA) Appointment,* State Technical Standards Committee, State of Delaware. 2010-present.
- *Invited Member,* Planning & Advisory Committee for the Town of Middletown Wastewater Treatment Facility Expansion Project. 2009-present.
- *Invited Panel Member*. Forum on Expanding the U.S. Biofuels Market. USDA/Rural Development/Farm Services Agencies (FSA). 2010-11.

PROFESSIONAL & INDUSTRIAL SERVICE

- *Member,* Advisory Board for EzyCure LLC (DE small business growing and processing medical hemp), Harrington, DE. 2020-present.
- *Member,* Land and Litter Challenge, Subcommittee on the Mass Balance of Nitrogen and Phosphorous on Delmarva. 2016-2018.
- *Invited Member,* Chesapeake Bay Programs' Implementation Workgroups. Agriculture Workgroup & Watershed Technical Workgroup. 2011-present.
- *Chair,* Chesapeake Bay Programs' Sub-committee on Quantifying Nutrient Generation by the Poultry Industry within the Chesapeake Bay Watershed (aka the Poultry Litter Subcommittee). (2011-16).
- *Chairman, Vice-Chair, and Past-Chair* of PM48 – Fruit and Vegetable Production Engineering. ASAE. 1999-2005.
- *Executive Committee Member and University Relations Officer,* Delaware Section of the American Society of Mechanical Engineers. 2003-2016.
- *National Science Foundation Invited Workshop Participant*: Engineering Solutions for Sustainable Food and Energy Supplies in the U.S. Co-Sponsored by NSF, NASA, and USDA. April 24-25, 2007, Washington, DC.
- *Scientific Committee Member,* International Symposium on the Application of Precision Agriculture for Fruits and Vegetables. 2007-08.
- *National Science Foundation Invited Workshop Presenter and Participant*: Future of Modeling in Composites Molding Processes. Co-Sponsored by NSF, DOE and APC, June 9-10, 2004, Washington, DC.
- *Member,* United Soybean Board National Technical Advisory Panel for Industrial Uses of Soybean Oil. (1999-2001).
- *Member,* ASAE PM 04 - Power and Machinery Publications Committee. 2003-present.
- *Member,* ASAE PM 01/02 - Power and Machinery Executive Steering Committee. 2001-2003.
- *ASABE Technical Committee Memberships*: PM 48 – Fruit and Vegetable Production Engineering (1996-present); PM 54 – Precision Agriculture (1998-99); PM 51 – Hydraulics (1998-00); ESH 04 – Ergonomics, Safety and Health (2003-present)
- *Member,* Scientific and Technical Advisory Committee, Center for the Inland Bays, Lewes, DE 2004-present.
- *SAE Technical Committee Memberships*: Alternate Industrial Lubricants (1997-00); Fluid Power (1997-99); Farm Equipment (1997-99, 2003-present)
- *ASME Committee Memberships*: Reliability, Stress Analysis and Failure Prevention Technical Committee (RSAFP) (2003-present)
- *Chair and/or Moderator,* Sessions at Professional Meetings
  - 2008 Conference on Application of Precision Agriculture for Fruits and Vegetables, Session on *Economics, Quality and Environmental Aspects of Precision Agriculture*.
  - 2007 Greater Philadelphia AIAA/ASME 3rd Annual Aerospace/Mechanical Engineering Mini-Symposium, Session on *Materials.*
  - 2007 ASABE International Annual Meeting – Session ESH-4, *Agricultural Safety and Health – Education and Intervention.*

- 2006 ASABE International Annual Meeting – Session ESH 216, *Advances in Safety Technology*.
- 2004 SAE Commercial Vehicle Engineering Congress and Exposition – *Advances in Off-Road Vehicle Electronics*.
- 2001 ASAE International Annual Meeting – Session 112 – *New Technology for Fruit and Vegetable Production Engineering*.
- 1999 SAE Off-Highway and Powerplant Congress and Exposition – *Alternative Industrial Lubricants.*

- *Reviewer*, Manuscripts
  - Journal of Mechanical Design, Transactions of the American Society of Mechanical Engineers (2).
  - Journal of Composites, Part A: Applied Science Manufacturing (4).
  - Journal of Sandwich Structures and Materials (3)
  - Peer-Reviewed Proceedings of the Design Engineering Technical Conference (2005) – Symposium on Reliability, Stress, and Failure Prediction (American Society of Mechanical Engineers) (2).
  - Peer-Reviewed Proceedings of Society for the Advancement of Materials and Processes (SAMPE) (1).
  - Peer-Reviewed Proceedings of the American Society of Mechanical Engineers Congress (2)
  - Peer-Reviewed Proceedings of the Design Engineering Technical Conference (2008) – 5th Symposium on International Design and Design Education (American Society of Mechanical Engineers) (3).
  - Transactions of the American Society of Agricultural Engineers (6)
  - Computers and Electronics in Ag (1)
  - Journal of Agricultural Engineering Research (1)
  - Biosystems Engineering (3)
  - Applied Engineering in Agriculture (7)
  - Canadian Journal of Bio-Engineering (1)
  - SAE Technical Papers (4)
  - HortTechnology (ASHS) (4)
  - Special Issue of Soil and Tillage Research (1)
  - Journal of Irrigation and Drainage Engineering, American Society of Civil Engineers (1)
  - USDA Peer-Reviewed Publications (1)
- *Reviewer*, Books
  - *Design of Machinery, 5th Edition*. McGraw Hill, New York, NY
  - *Mechanical Engineering Design*, 8th Edition. McGraw Hill, New York, NY
  - *Solid Works Workbook*. Prentice Hall, Upper Saddle River, NJ.
  - *Practical Reliability Analysis*. Prentice Hall Publishing, Upper Saddle River, NJ.
  - *Machine Design Series*. John Wiley & Sons, Inc., Hoboken, NJ
- *Reviewer*, Proposals
  - Kentucky Science and Engineering Foundation, R & D Excellence Funding Program (2006).
  - Canadian Natural Sciences and Engineering Research Council (NSERC) (2006).
  - The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) – Environmental Technology Development Grants Program (2004).
  - Canadian Natural Sciences and Engineering Research Council (NSERC) (2002).
  - National Review Panel, Small Business Innovative Research Program, Washington, D.C. (1999).
  - Small Business Innovative Research Program, Proposal Reviewer (1998, 1999, 2000, 2001, 2002, 2003, 2006, 2007, 2008).
- *Reviewer*, Papers for Northeast Agricultural and Biological Engineers (NABEC) Student Design Competition. (1992-2004, 2006, 2009, 2010).
- *Proctor*, Delaware Association of Professional Engineers. Fundamentals of Engineering Exam. (1998, 1999).

UNIVERSITY SERVICE

- *Advisor*, UD Trap and Skeet Club. (2017-2020).
- *Member*, UD Sustainability Fund Working Group. (2011-2013 term)
- *Member*, Advisory Panel for the Undergraduate Research Program (2009-13).
- *Member*, Senior Thesis Board, Undergraduate Research Program. (2003-13).
- *Instructor of Record*, Undergraduate Senior Thesis (UNIV 401 and 402). (2007-08).
- *Co-Advisor*, Solar Decathlon Competition. (2001-2003).
- *Member*, Search Committee for Project Manager in the Office of the Vice Provost for Research. (1999-2000).
- *Member*, Search Committee for Assistant Project Manager in the Office of the Vice Provost for Research. (1999).

- *Member*, Undergraduate Studies Committee, Faculty Senate (1995-97).

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES (CANR) SERVICE

- *Member*, Nutrient Management Committee (2012-13).
- *Member*, Search Committee for the Dean, College of Agriculture and Natural Resources (2012).
- *Member*, Search Committee for CANR Nutrient Management Faculty Member and Specialist (2012).
- *Member*, Search Committee for CANR Extension Environmental Quality and Management Specialist (2012).
- *Member*, Search Committee for CANR Newark Farm Manager (2008-10).
- *Member*, Search Committee for the Extension Vegetable Specialist. (2007-09).
- *Member*, College Promotion and Tenure Committee (2003-2005).
- *Member*, Advisory Committee for the CANR Industrial Partnership Program. (2003, 2005-present).
- *Member*, Search Committee for Animal and Food Sciences Assistant Professor - Food Processing. (2003).
- *Member*, Search Committee for CANR Associate Dean for Education and Research. (2003).
- *Member*, Search Committee for CANR Newark Farm Manager (2002).
- *Member*, Search Committee for Animal and Food Sciences Assistant Professor - Food Engineer (2002).
- *Member*, Review Committee for the CANR Research Partnership Program. (2001, 2005).
- *Member*, College Promotion and Tenure Committee (2000-2002).
- *Member*, Deans Advisory Committee (2000-2001).
- *Co-Host*, Delaware Vegetable Growers Trip to the Tulare Farm Show (w/ Ed Kee). (1999).
- *Member*, College Committee on Nutrient Management. (1998).
- *Member*, College Strategic Planning Committee (1997-98).

COLLEGE OF ENGINEERING (COE) SERVICE

- *Member*, Search Committee – CAD/CAM Machinist for the COE Student Machine Shop. (2021-22).
- *Advisor*, Solar Decathlon College of Engineering Team. (2019-21)
- *Member*, Search Committee – Laboratory Coordinator for Mechanical Engineering. (2018).
- *Faculty Manager and Coordinator*, Student Machine Shop. (2016-present)
- *Member*, Search Committee – CNC and CAD/CAM Master Machinist for the Student Machine Shop. (2017).
- *Member*, Search Committee – Replacement Master Machinist for the Colburn Research Machine Shop. (2017).
- *Faculty Consultant*, Reconfiguration of the Colburn Machine Shop Lathe Lifts (2010).
- *Member*, Advisory Committee for the Society of Automotive Engineers Club (2009-10).
- *Member*, Center for Composites Materials Honors Day Awards Committee (2004, 2007).
- *Member*, Search Committee - Master Machinist for the Student Shop. (2003).
- *Moderator*, Center for Composites Spring and Summer Research Symposiums (Fall, 2003, Spring, 2004, Spring 2005, Spring 2007, Spring 2008, Spring 2009, Spring 2010)
- *Faculty Coordinator*, Renovations of the Student Shop and Student Shop Website (2001–2004).

DEPARTMENT OF BIORESOURCES ENGINEERING SERVICE

- *Chair*, Promotion and Tenure Committee. (2012-13)
- *Member*, Promotion and Tenure Committee. (2007-08)
- *Chair*, Promotion and Tenure Committee. (2006-07)
- *Presenter*, RISE Program Presentation to High School Students. (Fall 2003, Spring 2004)
- *Member*, Department Promotion and Tenure Committee. (2001-02).
- *Member*, Search Committee for Assistant Professor/Extension in Irrigation/Water Resources Engineering (2000-01).
- *Member*, Search Committee for Assistant Professor/Extension Specialist in Poultry Production Engineering (2000-01).
- *Member*, Search Committee for Assistant Professor in Power and Machinery, Bioresources Engineering (2000).
- *Member*, Search Committee for Engineering Extension Associate. (1999).

DEPARTMENT OF MECHANICAL ENGINEERING SERVICE

- Member, Graduate Student-Industry Partnership (GSIP) Program (2018-present)
- *Chair*, ME Safety Committee (2017-18, 2018-19).
- *Member*, Planning Committee for the Future of Design Instruction (2009).
- *Member*, Design Curriculum Committee. (2005).
- *Member*, Laboratory Committee. (2000- present).

- *Advisor*, Student Chapter of SAE. (2000-01).
- *Member*, Graduate Student Recruitment Committee. (1999-00).