

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GLOBAL SHADE CORPORATION,
Petitioner,

v.

WITH-U E-COMMERCE (SHANGHAI) CO., LTD.,
Patent Owner.

IPR2023-00580
Patent 10,669,738

DECLARATION OF Wendy Reffeor, Ph.D.

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1. I, Wendy Reffeor, declare as follows:
2. I am making this declaration at the request of With-U E-Commerce.
3. I have been retained by With-U E-Commerce (Shanghai) Co., Ltd. (“With-U”) to provide an objective expert opinion in this matter.
4. I am being compensated for my work in this matter, and I am being reimbursed at cost for my expenses.
5. My compensation is not dependent on the contents of this declaration, any testimony I may give, or any outcome in this matter.
6. In preparing this Declaration, I considered the following materials:

Exhibit No.	Description
1001	U.S. Patent No. 10,669,738 B2 (the ’738 Patent)
1003	U.S. Patent No. 6,345,639 B2 (“Rousselle”)
1005	U.K. Patent No. GB 2,321,913 A (“Tsai”)

I. PROFESSIONAL BACKGROUND

7. My experience and qualifications are summarized in my C.V., a copy of which is provided as an exhibit to this report.
8. I have been working in the field of engineering for over 30 years. I received a Bachelor of Science in Mechanical Engineering degree in 1991, a Master

of Science degree in Mechanical Engineering in 1995 and a Doctor of Philosophy in Engineering Mechanics in 2001. I have worked extensively in academia, including as the Chair of Mechanical Engineering at Grand Valley State University. I currently serve as a tenured Professor and Chair of Mechanical Engineering at Grand Valley State University. My primary focus throughout my career has been engineering mechanics and mechanical design.

9. Since 1996 I have been responsible for the design and maintenance of the strength of materials laboratory and the mechanical testing laboratory at Grand Valley State University.
10. I have taught numerous undergraduate and graduate courses in mechanics, engineering, design, etc.
11. I have also overseen and advised a number of Master's Thesis projects, industry sponsored student projects, and student class design and build projects. These projects have included multiple devices incorporating scissor lifts and collapsible frames.
12. I was previously employed at Allison Engine Company in various manufacturing, inspection, and quality auditing roles.
13. I have also provided consulting with respect to die lifting blocks, mechanical

testing, strain gauges, and other fields.

II. LEGAL PRINCIPLES

14. I have been asked to provide my opinion as to whether claim 1 of U.S. Patent No. 10,669,738 (“the ’738 Patent”) would have been obvious to a person of ordinary skill in the art at the time of the alleged invention, in view of the prior art.
15. I am an engineer by training and profession, not a lawyer. I have not researched the law that may relate to this proceeding. The opinions I provide in this report involve the application of my training and technical knowledge and experience to the evaluation of certain prior art with respect to the ’738 patent.
16. Although I have not been involved as a technical expert in patent matters before and am not an expert in patent law, the attorneys from Schmeiser, Olsen and Watts, LLP have provided me with guidance as to the applicable patent law in this matter. The paragraphs below discuss my understanding of how I am to apply relevant legal principles in my analysis.
17. It is my understanding that a patent claim is invalid as obvious if differences between the subject matter of the claim and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time

the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

18. It is my understanding that in determining whether a claimed invention is obvious, one should consider the scope and content of the prior art, the level of ordinary skill in the relevant art, the differences between the claimed invention and the prior art, and whether the claimed invention would have been obvious to one of ordinary skill in the art in light of those differences.
19. I understand that certain objective factors, sometimes known as “secondary considerations” must, if present, be taken into account in determining whether a claimed invention would have been obvious. Such objective indicia as commercial success, long felt but unsolved needs, and failures of others may often be the most probative and cogent evidence of non-obviousness. Such evidence may often establish that an invention appearing to have been obvious in light of the prior art was not obvious. The person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the pertinent art at the relevant point in time. The person of ordinary skill is not an automaton, and may be able to fit together the teachings of multiple prior art references employing ordinary creativity and the common sense that familiar items may have obvious uses beyond their primary

purposes.

20. It is my understanding that in establishing obviousness, one must avoid the temptation to read into the prior art the teachings of the invention at issue and guard against slipping into the use of hindsight. The prior art itself, and not the applicant's achievement, must establish the obviousness of the combination. That is, a claim of the challenged patent cannot serve as a motivation to combine prior art references.
21. It is my understanding that when interpreting the claims of the '738 Patent, I must do so based on the perspective of a person of ordinary skill in the art at the relevant priority date. My analysis assumes a priority date of July 26, 2016.
22. I have not been asked to opine on, and have not analyzed, the priority date for any of the claims at issue in this petition for inter partes review ("IPR"). For the purposes of my analysis, I have been asked to assume the references relied upon by the Petitioners in this IPR meet the definition of prior art. Additionally, I have been asked to only give testimony on the obviousness of Claim 1 of the '738 Patent through combination of Rousselle and Tsai. I understand that even if all aspects of the claimed invention were individually known in the art that is not sufficient to establish a prima facie case of

obviousness without some objective reason to combine the teachings of the references as arranged in the claim under consideration. On this point, I understand that mere statements to the effect that a combination would have been obvious are not sufficient in the absence of articulated reasoning with rational underpinning to support the conclusion of obviousness. I understand that a mere combination of references disclosing individual elements itself does not satisfy the burden of proving invalidity by a preponderance of the evidence.

23. It is my understanding that if a proposed modification to a reference would render the prior art unsatisfactory for the intended purpose, or if the prior art teaches away from the proposed modification, then there is no suggestion or motivation to make the proposed modification.
24. It is my understanding that if a proposed modification or combination of prior art references would change the principle of operation of the prior art being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious.

III. PERSON OF ORDINARY SKILL IN THE ART

25. The '738 Patent relates to collapsible canopies and central locks. I was told to assume that a person of ordinary skill in the art would have had a

Bachelor's degree in mechanical engineering and two years of relevant experience. A recipient of other academic degrees may qualify as a person of ordinary skill if they have taken coursework or have experience in a pertinent technology. Additional education could offset less work experience; additional work experience could offset less education or coursework.

26. I objectively meet this POSITA criteria based on my qualifications and experience as set forth in my C.V. and for the reasons set forth above and below.
27. In the 2000s and 2010s, I was familiar with design and operation principles common in the mechanical arts. Both I and the engineers and engineering Bachelor's, Master's, and Ph.D. students that I worked with during the 2000s and 2010s had the requisite knowledge to make and use systems as described in the claims of the '738 Patent.
28. I have worked with and supervised mechanical engineers and engineering students and I know what their capabilities were in the relevant time period, how those engineers and engineering students would interpret and understand the claims of the '738 Patent, and how they would understand the disclosures in the other references discussed herein.

IV. CLAIM CONSTRUCTION

29. I have been advised that for this proceeding, the terms in the claims are construed based on their ordinary and customary meaning to a POSITA at the time of the invention unless the term has been clearly and unambiguously given a special definition in the specification. I understand that items of intrinsic evidence, including the specification, supplemented by the file history of the patent, are the best sources for understanding a term used differently from its ordinary and customary meaning. Extrinsic evidence, such as dictionaries and expert testimony, are relied on only when the ordinary and customary meaning and the intrinsic evidence are insufficient.
30. In my opinion, the terms of the '738 Patent do not require any construction as their plain and ordinary meaning is sufficient to fully understand the scope of the claims.

V. COLLAPSIBLE CANOPY FRAMES

31. Collapsible canopy frames allow for the ease of assembly and storage of portable canopies.
32. For these frames to perform their intended purpose, they must be small enough when collapsed to be easily transported, be stable in the unfolded state, support the weight of the canvas when in the unfolded state, be easily

erected, and allow for the intended purpose of the structure.

33. Prior collapsible frames have limited the usable volume of the erected structure as the frame itself intruded into the usable space. Additionally, they have had a variety of mechanisms to lock them in the unfolded state.

VI. THE '738 PATENT

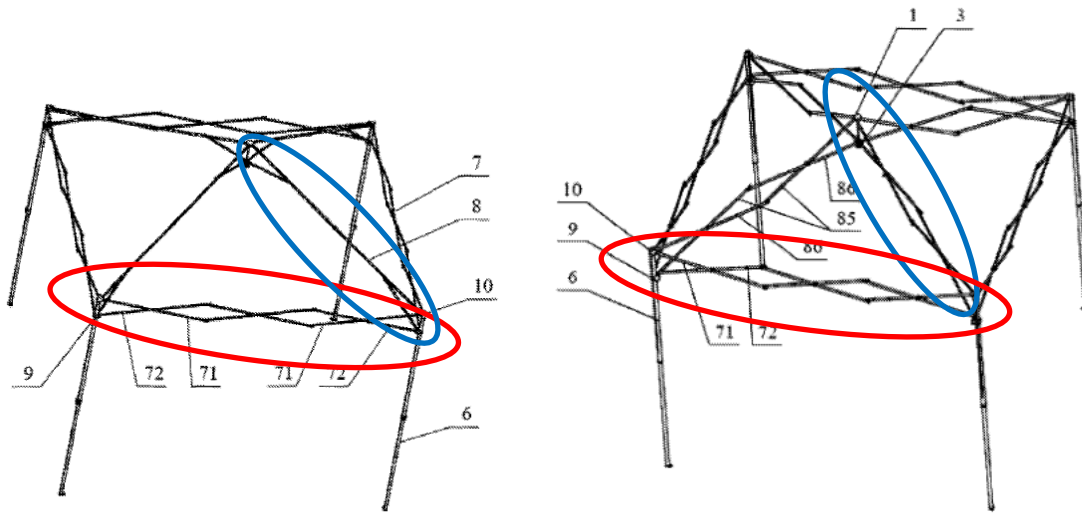
34. I reviewed the '738 Patent in preparation for this Declaration.
35. The '738 Patent addresses the issues of frame locking in the unfolded position, ease of structure erection, frame stability, and structural strength.
36. Claim 1 reads as follows:

A collapsible canopy frame, comprising:

- A. at least three supporting legs,
- B. a plurality of outer retractable units, each outer retractable unit connected between two adjacent supporting legs, each said outer retractable unit comprises a plurality of hinged X-shaped rod members, each X-shaped rod member comprises a first eave pipe and second eave pipe hinged to one another,
- C. a plurality of inner retractable units comprising inner ends, each inner retractable unit connected to a supporting leg, wherein said outer retractable units and said inner retractable units form a roof of said collapsible canopy frame, and
- D. a central lock, comprising:
 - 1. a center top cap,
 - 2. a center bottom cap,
 - 3. a center pole positioned between said center top cap and said center bottom cap, wherein said central lock is locked when said center pole is connected to both said center top cap and said center bottom cap, and wherein said center lock is unlocked when there is a disconnection between said center

bottom cap and said center pole, wherein said central lock locks said collapsible canopy frame in an unfolded state when said central lock is locked and permits said collapsible canopy frame to be folded into a folded state when said central lock is unlocked, wherein said inner ends of said inner retractable units are connected through said central lock.

37. Claim element 1B describes a retractable unit comprised of a plurality of hinged X-shaped rod members, shown on Figures 16 and 21 below (taken from the '738 Patent) circled in red. In this collapsible canopy frame, the X-shaped rod members, once locked in position by the central lock, provide lateral support to the supporting legs.
38. The plurality of inner retractable units in Claim 1C provide the required structure to connect the central lock mechanism to the vertical supporting legs and to support the canopy. These are shown on Figures 16 and 21 below (taken from the '738 Patent) circled in blue.
39. Claim 1D describes the central lock used to ensure the frame remains rigid and supports the canopy when in the unfolded state, shown below in Figure 2 of the '738 Patent.



'738 Patent Figures 16 and 21

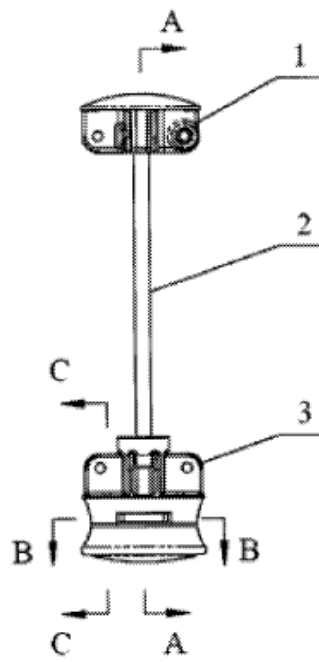


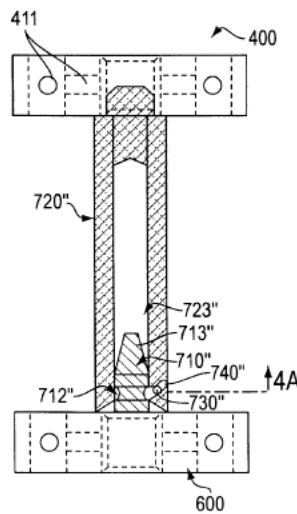
FIG. 2

'738 Patent Figure 2

VII. ART RELIED ON BY PETITIONER

a. U.S. Patent No. 6,345,639 B2 (“Rousselle”)

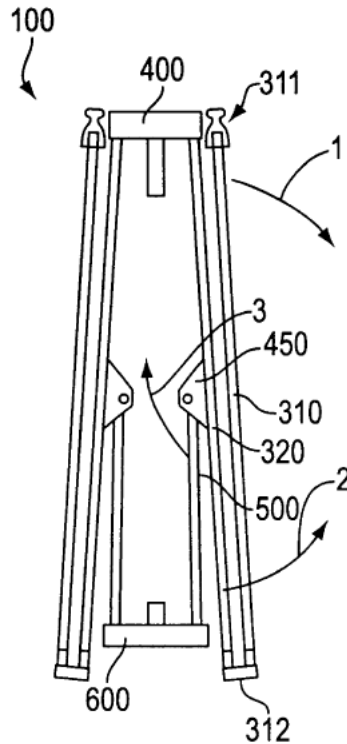
40. Rousselle describes a collapsible umbrella style shelter/tent with frame locking mechanism and assembly pole.
41. The locking mechanism, shown below from Rousselle Figure 4B, located at the center top of the umbrella tent, is composed of two clevises (400 and 600) that, when the umbrella tent is erected will be joined by a vertical post (720). The vertical post is rigidly connected to one of the clevises and includes a groove (712) that will engage with a moveable plate or pin (730) in the second clevis assembly when the two plates are pushed together.



Rousselle, Figure 4B

42. The upper clevis (400), shown below in Roussell Figure 1D, is pivotally attached to band bars (320) which are attached, at their other end, to the leg

tubes (310) of the umbrella tent. The lower clevis is pivotally connected to support bars (500) that connect the clevis to the band bars (320) connected to the upper clevis (400).



Rousselle, Figure 1D

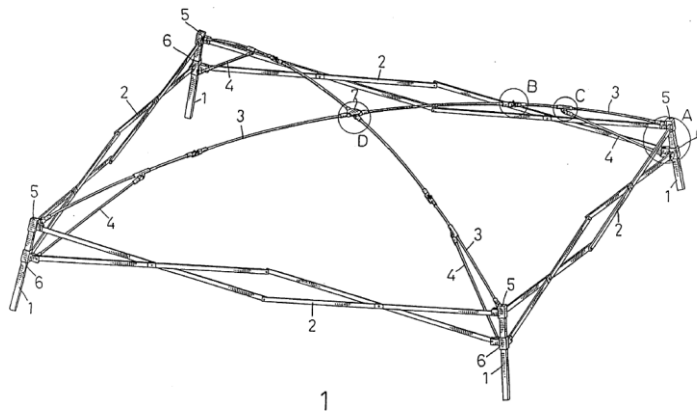
43. Although not required, the lock engagement/disengagement may be spring activated.
44. Tent feet (311) are described that simultaneously connect the leg tubes (310) to the floor of the umbrella tent and/or the ground. These feet allow the shelter to be erected with no further clips or other locking elements required to engage the tent legs.

45. If the frame is installed inside the umbrella tent, the frame will impart an outward force against the cover creating a more rigid “unibody” type of structure.
46. Rousselle depicts a movement of the leg tubes 310 in an inverting motion (referred to as “Action 1”) during the unfolding process. This is shown as Arrow 1 in Rousselle’s Figure 1 D and is described in column 13, lines 5–21. Action 1 involves the leg tubes 310 pivoting from being upward facing to downward facing.
47. Hinges (312) are described that allow for a nearly ninety-degree angle between the leg tubes (310) and the “ceiling” of the shelter. See column 11, lines 4 – 33. These hinges provide a stop for Action 1, unfolding the tent legs, as described in column 13, lines 5 - 8.
48. Throughout the teachings of Rousselle, it is clear the leg tubes 310 and band bars 320 are flexible. Figures 1(A) through 1(C) and 18(A) which show the assembled structure all show curved band bars 320. A structure cannot be erected from Figure 1(D), 18(B), 19(A), 19(B), or 19(C) without flexing these members. The fact that the hinges described cannot reach ninety degrees is due to the forces applied by the flexed band bars 320. Additionally, Rousselle clearly describes the potential energy caused by

flexing the frame assisting in erecting the structure, for example, discussing the “flexure of the band bars 320”) in column 11, lines 34 – 40 and how the legs are caused “to flex and to thus store potential energy” in column 13, lines 5–21.

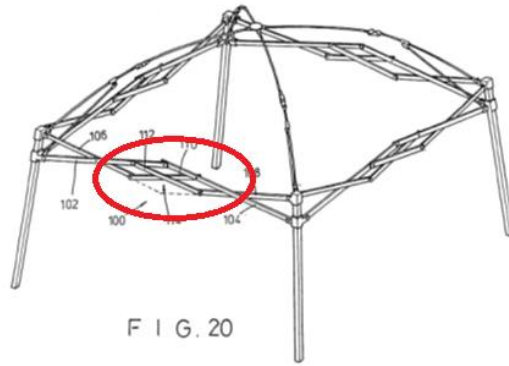
b. United Kingdom Patent Application GB 2,321,913 A (“Tsai”)

49. Tsai describes a shelter frame with complex scissors-type linkage and locking mechanisms on the legs.
50. An example of Tsai’s shelter frame is shown in Tsai, Figure 1 below.



Tsai, Figure 1

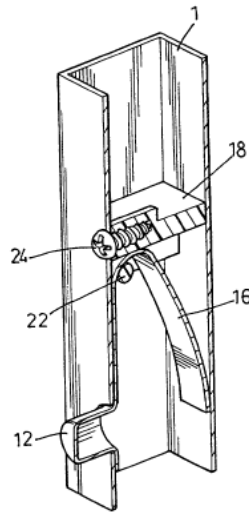
51. Tsai teaches the use of first and second scissoring devices, circled in red in Tsai Figure 20 below, to increase the central clearance on the sides of a structure. This can be seen in Figure 20, below, and is described in Amended Claim 1 (pg. 22, paragraph 1), Amended Claim 2 - 6 (pg. 23) and Amended Claim 10 (pg. 24) of Tsai.



Tsai, Figure 20

52. Amended Claims 7 and 8 (pg. 23) describe the attachment of these scissoring mechanisms to the vertical supports (poles 1) of the frame.
53. Amended Claim 1 (pg. 22, paragraphs 2 and 3), and Amended Claim 9 (pg. 24) describe the canopy support mechanism. Throughout the document, this canopy support mechanism can be seen to be composed of flexible elements, including canopy supporting rods 3. All figures showing embodiments of the invention are shown with arched canopies and canopy supporting rods including Figure 20 (above) and Figure 1. All embodiments of the canopy supports, Figures 1 – 15 and 20 – 22, are shown with circular canopy supporting rods 3 which would allow for this flexure.
54. Additionally, Tsai teaches the use of a spring-loaded locking mechanism (Tsai, Figure 19 below) on the legs/poles of the structure to ensure the structure remains in the unfolded state. This is described in Amended Claims

11 and 12 (pg. 24).



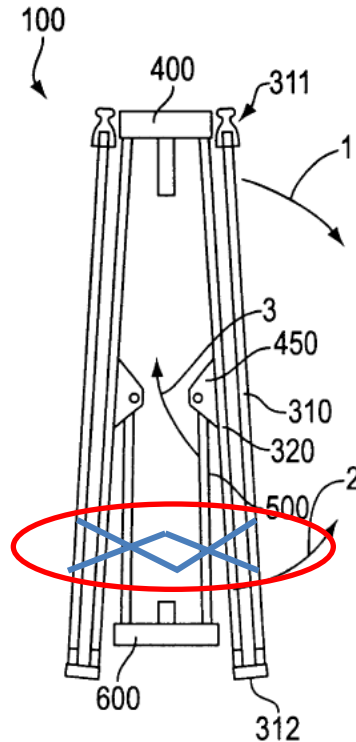
Tsai, Figure 19

55. In Tsai's disparagement of prior art solutions, he clearly teaches that a double clevis, central locking mechanism is inferior to the leg locking mechanism proposed as it often requires a second person to push upward at the center of the structure (pg. 2, lines 19 – 22) and that it reduces the head space within the structure (pg. 2, lines 17 – 19 and pg. 3, lines 3 and 4).

**VIII. A POSITA WOULD NOT ADD TSAI TO ROUSSELLE TO
ARRIVE AT THE STRUCTURE OF CLAIM 1 OF THE '738
PATENT**

56. For several reasons, a POSITA would not start with Rousselle's umbrella tent and add features from Tsai to create the structure of Claim 1 of the '738 Patent.

57. First, a POSITA would see that it is impossible to add the scissoring mechanism from Tsai to the frame of Rousselle, as the scissoring mechanism would prevent the frame from being deployed (see Rousselle, Figure 1D below). Action 1, unfolding the tent legs, as described in column 13, lines 5 – 21 requires free rotation of the leg tube (310) and tent foot (311) from upward facing to downward facing. The blue lines added to Rousselle, Figure 1D and circled in red, represent a scissoring mechanism. As can be seen in the figure, attaching these scissoring mechanisms (shown in blue lines) to the leg tubes (310) prevents the legs from rotating 180 degrees outward and downward as required to perform Action 1.



Rousselle, Figure 1D

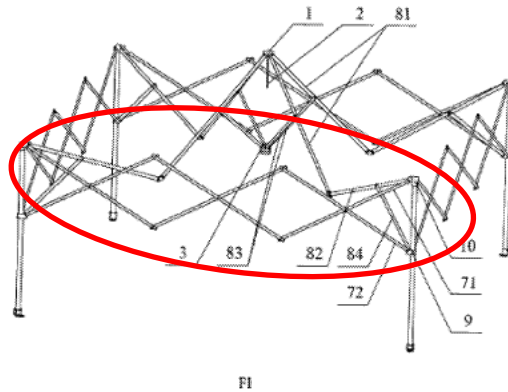
58. Secondly, a POSITA would not have been motivated to make the combination because the umbrella tent described in Rousselle relies on flexible support elements (leg tubes 310 and band bars 320). A POSITA would recognize that these flexible leg elements could not effectively be combined with the scissoring features of Tsai, because Rousselle's flexible leg elements could neither support the weight of the scissor elements, nor could they maintain those elements in the unfolded position, because even with a locking mechanism the flexibility of leg tubes 310 and band bars 320

would allow the scissors to be collapsed and the leg elements to be moved toward each other instead of being locked in the unfolded position.

59. Additionally, nothing in Rousselle implies a need for additional support between the leg tubes 310 of the structure. In fact, structures such as Rousselle's typically do not have connections between the legs (nor would such connections be desirable given the added weight, cost, and complications such connections would introduce for no apparent benefit).

**IX. A POSITA WOULD NOT ADD ROUSSELLE TO TSAI TO
ARRIVE AT THE STRUCTURE OF CLAIM 1 OF THE '738
PATENT**

60. For several reasons, a POSITA would not start with Tsai and add features from Rousselle's umbrella tent to create the structure of Claim 1 of the '738 Patent.
61. Tsai clearly solves the problem of having the lowest point of the scissoring structure in the center of the side of the structure by using the double scissoring structure seen above in Tsai, Figure 21. This is different from the way in which that problem is solved in the '738 Patent. In the '738 Patent, three scissoring pairs, shown below in Figure 19 of the '738 Patent, are used to ensure that the highest point in the scissoring mechanism is at the center of the wall.



'738 Patent Figure 19

62. Tsai clearly locks the unfolded structure in place using leg locks, and in so doing, specifically describes a central locking mechanism as inferior. As discussed above, Tsai teaches that a double clevis, central locking mechanism is inferior for 2 reasons: 1. It often requires a second person to push upward at the center of the structure; and 2. It reduces head space within the structure. Therefore, Tsai teaches against a central locking mechanism because it indicates that the central locking mechanism is not as effective as leg locks. Reading Tsai, a POSITA would have no reason to refer to Rousselle for the use of the locking mechanism as Tsai clearly teaches against its use.
63. Additionally, the flexible canopy support rods 3 used in Tsai would be unable to support locking the frame in position from the center as would be required were a central locking mechanism to be added. A POSITA would

see that a central locking mechanism would allow the legs/poles to move independently by simply flexing or unflexing the canopy structure and canopy support rods 3 even with the central lock.

64. Finally, Tsai, page 10, lines 25 - 35, and page 11, lines 1 – 11, describes how his frame is erected. This is done by moving the legs/poles outward until the leg locks lock, thus securing the frame in the upright position. This teaches away from deploying the frame by pushing upward on a central locking mechanism. A POSITA would see that not only is this true, but the flexible canopy support rods 3 in Tsai would not allow central deployment/activation as they would be unable to push the scissoring members outward.
65. Everything written in Tsai clearly teaches against incorporating a central locking mechanism such as that found in Rouselle. Likewise, one would not use such a central lock to control or drive locking of Tsai's frame.

X. CONCLUSION

66. In conclusion, it is my view that claim 1 of the '738 Patent would not have been obvious to a POSITA at the time of the invention, whether from the addition of features from Tsai to Rouselle or from the addition of features from Rouselle to Tsai. For the reasons stated above, there would not have been a motivation to combine the references, and even if the references were

combined, the resulting device would not function.

67. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: November 10, 2023



Wendy S. Reffeor, Ph.D.

WENDY SUE REFFEOR

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Mechanical engineer with thirty plus years of industry and academic experience. Academic experience/interests are primarily in industry sponsored product and machine design, and biomechanics. Taught twenty-four primarily machine design and mechanics courses spanning Freshman to Graduate levels. Actively involved in cooperative education program as well as co-coordinating senior project program. Advised over twenty graduate student theses and projects. Mentored roughly forty industry sponsored senior projects as well as over twenty industry sponsored class projects. Performed consulting for eleven different projects. Industry experience in many aspects of quality control including ISO 9000 certification, nondestructive testing, gage design, and quality auditing.

Recipient of multiple grants including an NSF grant titled, "Using Assistive Device Design to Implement Cornerstone Project Based Learning." Significant academic leadership including program chair for two programs.

EDUCATION

Ph.D.	Engineering Mechanics	Michigan State University	2001
Dissertation Title: A Three-Dimensional Dynamic Analysis of the Human Hand for Predicting Tendon, Ligament and Nerve Irritation in the Carpal Tunnel During Typing			
Advisor: Robert W. Soutas-Little			
M.S.	Mechanical Engineering	Indiana University-Purdue University, Indianapolis	1995
B.S.	Mechanical Engineering Machine Design Emphasis	Kettering University (GMI Engineering & Management Institute)	1991
Thesis Title: Comparison of Eddy Current and Fluorescent Penetrant Inspection for the T800 Engine Gas Generator Disks			

TEACHING EXPERIENCE

1996 - Present	Grand Valley State University	Allendale, MI
Positions:		
2021 – Present	Professor and Chair, Mechanical Engineering	
2014 – 2021	Associate Professor	
2012 – 2014	Assistant Professor	
2004 – 2012	Adjunct and Visiting Professor	
2001 – 2004	Assistant Professor	
1996 – 2001	Adjunct Professor	
<i>Courses Taught:</i>		
EGR 101—Computer Aided Design and Manufacturing Laboratory (coordinator 2 years)		
EGR 106—Introduction to Engineering Design I (coordinator 1 year)		
EGR 107—Introduction to Engineering Design II		
EGR 209—Mechanics and Machines (coordinator 12 yrs)		
EGR 210—Solid Mechanics		
EGR 220 (EGR 103)—Measurement and Analysis Laboratory		

EGR 250—Materials Science Laboratory
 EGR 289—Engineering Professionalism (coordinator 1 semester)
 EGR 290—Engineering Co-op 1
 EGR 302—Engineering Decision-Making in Society (new course development and coordinator)
 EGR 309—Machine Design I (coordinator 12 years)
 EGR 310—Machine Design I Laboratory (coordinator 12 years)
 EGR 312—Dynamics
 EGR 390—Engineering Co-op 2
 EGR 409—Machine Design II
 EGR 485—Senior Project I (Lecture and Lab, co-coordinator 7 years)
 EGR 486—Senior Project II (co-coordinator 7 years)
 EGR 490—Engineering Co-op 3
 EGR 616—Experimental Mechanics (new course development)
 EGR 699—Transducers (new course development)
 EGR 699—Continuum Mechanics and Elasticity (new course development)
 EGR 699—Kinematics (new course development)
 EGR 699—Partial Differential Equations (new course development)
 EGR 699—Viscoelasticity (new course development)

Summer 2019 Visiting Assistant Professor John Cabot University
Course Taught: EGR 209—Mechanics and Machines

Rome, Italy

1996 – 1999 Michigan State University

East Lansing, MI

Teaching Assistant, Department of Materials Science and Mechanics,

Courses Taught:

Instructor

MSM 205—Statics

MSM 306—Dynamics

Head Teaching Assistant

MSM 206—Mechanics of Materials Laboratory

Teaching Assistant

MSM 205—Statics,

MSM 306—Dynamics,

MSM 206—Mechanics of Materials Laboratory

INDUSTRY EXPERIENCE

1991-95 Allison Engine Company

Positions: Inspection Supervisor, Nondestructive Testing Supervisor/Engineer, Quality Engineer, Quality Auditor, Senior Quality Auditor

Responsible for: Gage use and design, coordinate measuring machine programming, ultrasonic inspection, eddy current inspection and x-ray inspection techniques used in manufacturing, fluorescent penetrant and magnetic penetrant inspection review, developing and revising quality control procedures, working with manufacturing and design engineers to improve manufacturability of parts, spearheading efforts to improve procedural compliance and quality in manufacturing

Special Accomplishment: developed and implemented quality plan and procedures at a satellite facility

1986-91 Cooperative Education Student, Allison Gas Turbines, Division of General Motors

Assignments: Chemical Analyst, Inspection Supervisor, Sport (Student Run Plant Recycling Program) Coordinator, Reliability Engineer, Quality Engineer, Nondestructive Testing Engineer, Nondestructive Inspection Supervisor

FUNDED GRANTS

- Michigan Space Grant Consortium, Sponsorship of the 5th Grade Classes at Sibley Elementary School, \$3000. (2001)
- Michigan Space Grant Consortium, Validation of A Three-Dimensional Dynamic Analysis of the Human Hand for Predicting Tendon, Ligament and Nerve Irritation in the Carpal Tunnel, \$5000. (2002)
- GVSU FTLC Pew Technology Enhancement Grant, Increasing Hands on Learning in Machine Design Courses, \$2482. (2004)
- GVSU FTLC Pew Technology Enhancement Grant, Tensile Tester Upgrade, \$2944. (2012)
- National Science Foundation, Using Assistive Device Design to Implement Cornerstone Project Based Learning, \$180,000. (2013)
- Reffeor, W. S., "Mini-Grant--Recovery Effects on the Performance of Athletic Shoes," Sponsored by CSCE, Grand Valley State University, \$400.00. (2020)
- Reffeor, W. S., Lee, Y., Alderink, G. J., Chapman, A., Miller, B., Crellin, C., "Thinking outside of the triangle for femoral neck fracture fixation: comparison of a standard inverted triangle to a novel cortex-supporting, divergent triangle screw construct," Sponsored by CSCE, Grand Valley State University, \$10,000.00. (2020)
- Crellin, C., Reffeor, W. S., Lee, Y., Alderink, G. J., Chapman, A., Miller, B., "Thinking outside of the triangle for femoral neck fracture fixation: comparison of a standard inverted triangle to a novel cortex-supporting, divergent triangle screw construct," Sponsored by Spectrum Health Trauma Research Institute, Private, \$21,448.00. (2020).
- Reffeor, W. S., "Finite Element Module Development GA for Better Understanding and Visualization of Machine Elements Special Projects GA", Sponsored by GVSU Graduate School, 9-Month, Full-time Graduate Assistantship. (2021)

UNFUNDED GRANTS

- Iannelli, J., Sozen, M. (Principal), Plouff, C. J. (Co-Principal), Barakat, N. (Supporting), Corneal, L. M. (Supporting), Mokhtar, W. A. (Supporting), Reffeor, W. S. (Supporting), "A West Michigan Co-operative-Education Energy Industrial Assessment Center," Sponsored by US Department of Energy, Federal, \$1,859,309.00. (2011).
- Barakat, N. (Principal), Reffeor, W. S. (Supporting), "Integrating Standards Education into Courses in Mechanical and Industrial Engineering (ISEC)," Sponsored by NIST, Federal, \$74,912.00. (2018).
- Norouzi, M., Reffeor, W. S., Krug, B. G., "Develop an Automatic Swing for Disabled Kids," Sponsored by PEW FTLC, Grand Valley State University, \$3,000.00. (2018).
- Reffeor, W. S., Hall, J. (Co-Principal), "Accelerated and Real Time Aging Effects on 3D Printed Photopolymer Parts," Sponsored by CSCE, Grand Valley State University, \$3,900.00. (2020).
- Reffeor, et. al., "Racial Equity in STEM—Multi-Institution Collaborative Grant", Sponsored by NSF Racial Equity in STEM, Partners—Fort Valley State University, St. Augustine's University, \$7,749,551.

AWARDS

- | | |
|------|---|
| 2023 | Grand Valley State University Nominee for Michigan Association of State Universities Distinguished Professor of the Year Award |
| 2022 | Glenn A. Niemeyer Award, Grand Valley State University |
| 2016 | Pew Teaching Excellence Award, Grand Valley State University |
| 2011 | ASME Dedicated Service Award |
| 2004 | Best Paper Award— Reffeor, W., Blekhman, D., Connecting Rod Design Competition—Solid Mechanics Multiple Failure Mode Design and Testing Project, Proceedings of 2004 Annual Conference and Exposition, 2004 |
| 1997 | Graduate Student of the Year—Michigan State University, Mechanics |
| 1991 | Graduated Cum Laude |
| 1989 | Tau Beta Pi—Engineering Honor Society (inducted junior year) |

- 1989 Pi Tau Sigma—Mechanical Engineering Honor Society (inducted junior year)
1987 Phi Eta Sigma—Freshman Honor Society

LABORATORY EXPERIENCE

- 1996-Present Grand Valley State University, Design and Maintenance of Strength of Materials Laboratory
Equipment Design and Used: Combined Loading Apparatus, Stress Concentration Apparatus, Statically Indeterminate Loading Apparatus, Mohr's Circle Visualization Apparatus, Composite Materials Analysis, Beam Deflection Apparatus, P3 Strain Indicator, Instron Tensile Tester, MTS Tensile Tester
1995-96 Michigan State University, Creep and Tensile Testing of Titanium Aluminide
Equipment Used: Tensile Tester, Creep Frame, Environmental Scanning Electron Microscope, Scanning Electron Microscope, Electropolisher

LEADERSHIP POSITIONS

- 2020- Chair, Mechanical Engineering Program Committee, Padnos College of Engineering and Computing, GVSU
Winter 2019 Chair, Mechanical Engineering Program Committee, Padnos College of Engineering and Computing, GVSU
2016-18 Chair, Integrated Engineering Program Committee, Padnos College of Engineering and Computing, GVSU
2013-20 Member Padnos College of Engineering and Computing Curriculum Committee
2007-10 Chair, ASME International Student Design Committee
2007-10 Member, ASME International Committee on Student Development
2003-10 Member, ASME International Student Design Committee
2001-03 Padnos School of Engineering Computer Committee Chair
2001-05 American Society of Mechanical Engineers Liaison to the Girl Scouts of America
2000-03 Faculty Development Task Force Chair--Board on Engineering Education, American Society of Mechanical Engineers
2000-01 Leadership Development Intern—Council on Education, American Society of Mechanical Engineers
2000-03 Treasurer—West Michigan Section, American Society of Mechanical Engineers
1999- Mechanical Engineering Curriculum Committee, Grand Valley State University
1999- Standardized Leadership Trainer—American Society of Mechanical Engineers
1999-00 Vice Chairperson—West Michigan Section, American Society of Mechanical Engineers
1998-00 Student Design Competition Chair—American Society of Mechanical Engineers, Region V
1998 Graduate Student Representative—Graduate Committee, Department of Materials Science and Mechanics, Michigan State University
1996-97 Graduate Student Representative--Search Committee for the Vice President of Research and Graduate Studies at Michigan State University
1996 Treasurer—Tau Beta Pi, Michigan Alpha Chapter

TECHNICAL AND PROFESSIONAL SOCIETIES

American Society of Mechanical Engineers
American Society of Engineering Education
American Society of Biomechanics
International Society of Biomechanics

TEACHING INTERESTS

Incorporating Design Projects in Traditional Engineering Courses, Teaching Methods, Project Based Learning, Team-based Learning, Statics, Strength Materials, Dynamics, Machine Design, Vibrations, Computer Use in Engineering Education

TEACHING AND LEADERSHIP WORKSHOPS

Observed, Exceed Teaching Workshop, United States Military Academy, West Point, New York, 2000 Participated, “How to Engineer Engineering Education”, Bucknell University, Lewisburg, PA, 2003
Designed and Co-lead with Catherine Frerichs, Grand Valley State University, May 2003 – April 2004
Participated, Ensuring Student Engagement in a Flipped Classroom Using Team-based Learning, ASEE 2015 Annual Conference and Exposition, Seattle, WA, 2015
Participated, Leadership Development Program, Grand Valley State University, Grand Rapids, MI, Winter 2016

LICENSURE

1995 Engineering Intern License Number ET39500378
1994-97 Certified Quality Auditor, American Society of Quality Control

RESEARCH INTERESTS

Integrating project based learning in the mechanical engineering curriculum, integrating FEA in mechanics and machine design courses, mechanical testing, integrating entrepreneurship in engineering education, biomechanics

REFEREED JOURNAL PAPERS

T.R. Bieler, G. Dowling, W.S. Reffeor, “Effects of oxygen, water vapor, argon, air and exposure history on fracture strength of Ti-48Al-2Nb-2Cr notched tensile specimens,” Materials Science and Engineering, A239-240 (1997), p. 330-335.

REFERREED CONFERENCE PROCEEDINGS

Corneal, L. M., Pung, C. P., & Reffeor, W. S. (2020). Linking Co-op and Senior Project: Required Technical Proposal Writing Embedded in the Second Co-op Rotation. Montreal, Quebec: 2020 ASEE Annual Conference and Exhibition.

Reffeor, W. S. (2018). Using FEA as a Pedagogical Tool for Teaching Machine Component Design. Salt Lake City: 2018 ASEE Annual Conference and Exposition.

Farris, J., Reffeor, W. S., & Kenyon, L. K. (2017). Best practices for working with non-technical project sponsors. 2017 American Society of Engineering Educators (ASEE).

Bhatta, R., Reffeor, W., Comparison Of Load Carrying Capacity Of Three And Four Lobed Polygonal Shaft And Hub Connection For Constant Grinding Diameter, 2016 ASME IMECE, Phoenix, AZ

Reffeor, W., Farris, J., Student Perceptions of Course Projects as a Learning Tool, Proceedings of 2016 ASEE Annual Conference and Exposition, New Orleans, LA

Reffeor, W., Farris, J., An Iterative Approach to Implementing Sponsored Design and Build Projects, Proceedings of 2015 ASEE Annual Conference and Exposition, Seattle, WA

Reffeor, W., Using Assistive Device Design To Implement Cornerstone Design In A Junior Level Machine Design II Course, Proceedings Of The ASME IDETC/CIE 2014 August, 2014, Buffalo, New York

Reffeor, W., Joo, Sung-Hwan, Pung, C., Using the ASME Student Design Competition as the Culminating Design and Build Experience in a Freshman Level CAD/CAM Course, 2nd Year, Proceedings of 2013 ASEE Annual Conference and Exposition, Atlanta, GA

- Reffeor, W., Joo, Sung-Hwan, Pung, C., Using the ASME Student Design Competition as the Culminating Design and Build Experience in a Freshman Level CAD/CAM Course, Proceedings of 2012 First Year Engineering Experience (FYEE) Conference, Pittsburgh, PA
- Reffeor, W., Blekhman, D., Connecting Rod Design Competition–Solid Mechanics Multiple Failure Mode Design and Testing Project, Proceedings of 2004 ASEE Annual Conference and Exposition, Salt Lake City, Utah
- Reffeor, W., Incorporating Design in an Introduction to Dynamics Course, Proceedings of 2002 ASEE Annual Conference and Exposition, Montreal, Canada
- Reffeor, W., Ray, J., Incorporating Experimental Design in a Mechanics of Materials Course, Proceedings of 2002 ASEE Annual Conference and Exposition, Montreal, Canada
- Marvel, J., Reffeor, W., Crossing Course Boundaries: A Joint Class Project between Machine Component Design and Manufacturing Courses, Proceedings of 2002 ASEE Annual Conference and Exposition, Montreal, Canada
- Adamczyk, B., Reffeor W., Math Literacy and Proficiency in Engineering Students, Proceedings of 2002 ASEE Annual Conference and Exposition, Montreal, Canada
- W.S. Reffeor, R.L. Soutas-Little, “Termination of Higher Order Polynomial Functions Initiated by Use of Macauley Functions,” Proceedings of 1999 ASEE Annual Conference and Exposition, Charlotte, NC

POSTER PRESENTATIONS

- Scarber, S. (Presenter & Author), Reffeor, W. S., Student Scholarship Day, "Design and Manufacturing of a 3D Printed Foot For High Cycle Count Compression Testing," GVSU, Allendale. (April 10, 2019).
- Black, K. (Presenter & Author), Vollmers, C. (Presenter & Author), Reffeor, W. S., Student Scholarship Day, "Experimental Comparison Between a 3D Model Foot and a Metal Plunger for Determining Energy Return in Running Shoes," GVSU, Allendale. (April 10, 2019).
- Kenyon, L. K., Farris, J., Reffeor, W. S., The 2017 American Society of Engineering Educators (ASEE) Conference & Exposition, "Best practices for working with non-technical project sponsors," Columbus, Ohio. (June 27, 2017).

DIRECTED STUDENT LEARNING

Master's Thesis/Project Committee Chair

- “Comparison of Median Nerve Pressure in Bicycling,” Advised: Genevieve Wisby, (May 2023 – Present)
- “Improving FEA Accuracy of a Rocker Arm through Comparison with Known Failures,” Advised: Zakary Smith, (September 2022 – Present),
- “Testing the Cutting Forces of Biologic and Synthetic Cancellous Bone,” Advised: Matthew Hartwell, (May 2022 – Present)
- "Investigation of Divergent Triangle Construct For Internal Fixation of Vertical Femoral Neck Fractures Using Experimental and Finite Element Analysis Methods," Advised: Hannah Rainey, (August 2020 - Present)
- “Simulation and Validation of Thermal Design Improvement of DJ Clearview Mirror Suitcase Tester using Star CCM+,” Advised: Joshua Veldheer, (September 2022 – August 2023)
- “Structural Reinforcement of Repurposed Shipping Containers,” Advised: Aminur Rahman, (January 2023 – May 2023)
- “Recovery Effects on the Performance of Athletic Shoes,” Advised: Erich Hagen, (August 2019 – May 2021)
- "Feasibility of Continuous Light Interface Production Technology to Additively Manufacture Low-Volume Medical Device Components," Advised: Aldo Fanelli, (July 2018 - December 2019)
- "Shape Corporation Pre-Pierce Press Optimization," Advised: Eric VanDyke, (May 2018 - April 2019)
- "Design of Stryker Medical Test Lab Tip Stability Evaluation System," Advised: Christopher Jones, (August 2017 – October 2018)
- "The Design of an Automotive Inside Rearview Mirror Alternate Toggle Mechanism," Advised: Robert Esser, (August 14, 2015 - December 5, 2016)
- "Performance Evaluation of Three and Four Lobe Isometric Polygonal Shaft and Hub," Advised: Ravi Bhatta, (August 2014 - February 29, 2016)

Master's Thesis/Project Committee Member

- “Using Centrifugal Forces and Turbulent Flow to Increase the Capacity of Air Disinfection UVC Light Air Disinfection Device”, Advised: David Brinkmeier, (January 2022 – July 2023)
- “Concurrent Validity Study of 3D Motion Measurement Systems: VICON vs. Xsens,” Advised: Pias Das, (May 2021 – December 2022)

"Development of a Novel Device for Snake Envenomation Therapies," Advised: Kelly Martin, (September 2020 – August 2021)

"A CFD Study on the Performance of High-Speed Planing Hulls," Advised: Mowgli Crosby, (February 2019 – December 2019)

"The Design, Analysis, Development, and Test of a High-Energy Trauma Prevention Safety Device," Advised: Brooks Schaefer (June 2015 - December 2018)

"Application of Genetic Algorithm in Multi-objective Optimization of an Indeterminate Structure with Discontinuous Space for Support Locations," Advised: Rahat Sultana, (October 2015 - September 2016)

"Remote Control Software Design for the De-Palletizing System," Advised: Cong Yang, (August 2016)

"Aerodynamics of Race Car Wings, A CFD Study," Advised: Simon Drurer, (February 2015 - March 2016)

"Exploration of the Validity of the Two-Dimensional Sagittal Plane Standing Long Jump Model," Advised: Lauren Hickox, (September 2013 - July 2014)

"Mechanotransduction in Mouse Models – Effects of Mechanical Loading on the Ulna and Femur," Advised: Andrew Vander Moren, (November 2012 - May 2013)

"Dominant Upper Extremity Kinematics and Muscular Activity in Sonographers during Kidney Scanning," Advised: Jennifer Edwards, (September 2011 - May 2012)

INDUSTRY SPONSORED SENIOR PROJECT FACULTY ADVISOR

2023

Primary Advisor

Engineered Power Components, Key Seat Automation
Michigan Launch Alliance, Rocket Engine
Roman Manufacturing, Rogoski Integrator
Woodward, Inc., Vacuum Furnace

Secondary Advisor

Attwood - Confidential,
Autocam Medical, Press Fit Automation
Engineered Power Components Heat Treat Load
Gentex, FDM Torque Drive
Koops, Automated Panel Drill
Magna Mirrors, OSM Tester
Weiss Technic, Confidential
Woodward, Inc., Nozzle Test Stand Redesign and Build

2022

Primary Advisor

Autocam Medical, Automated Inspection
Dewys Manufacturing, Automated Paint Cap Sorter
Swoboda, Automated Winton Coil Recycler
T & T Tools, Automated Rod End Threader

Secondary Advisor

Autocam Medical, Automated Assembly Cell
ABK – Confidential
Herman Miller, Tote Destacker
Lockheed Martin, Additie

2021

Primary Advisor

ABK, Confidential
Rivian, Maintenance Station
Styker, Automated Life Testing Device

Secondary Advisor

E3, PCB Design
Egen Foods, Automated Bar Cutting Line
Integrated Packaging Machinery, Robotic Cable Management

Log Boiler, Automated Pellet Stove Feeder
ODL, Window Pressure Relief Valve
T & T Tools, Hook Bender
2020

Primary Advisor

ABK, Confidential
Jack Jumper, Confidential
Woodward, Inc., Test Stand Redesign

2019-Primary Advisor

Buehler-Prince, Die Block Transportation Cart
Koops, Edge Folding

2018-Primary Advisor

ABK, Confidential
Koops, Head Liner Adhesive Cure

2016-Primary Advisor

Shape Corporation, Bumper Test Stand

CONSULTING EXPERIENCE

Perrigo, Allegan, MI, Analysis of Two Bottle Cap Safety Testing Apparatuses, June 2001
Holland Group, Muskegon, MI, Strain Gage Installation and Use Course, September 2002
Machine Design, Wentzell, Delmar Cengage Learning, 2003—Served as reviewer
Siemens Water Technologies Corporation, Holland, MI, Tensile Testing of Filter Press Tie Bars, June 2007
Joseph A. Paparella, Grand Rapids, MI, Retaining Wall Analysis, September 2010
Great Lakes Laminators, Montague, MI, Mechanical Testing of Laminated Wood Beams, December 2012
Fundamentals of Machine Design (SI Edition), Juvinall and Marshek, Prentice-Hall, 2013—Converted homework problems to SI and generated solutions manual
Bissell, Grand Rapids, MI, Tensile Testing of 3D Printed Polymers, April, 2015
HS Die and Engineering, Grand Rapids, MI, Lift Block Analysis, May 2015, June 2017
Shigley's Mechanical Engineering Design, Budynas and Nisbett, McGraw-Hill, 2017—Storyboarding homework problems
Bucher Hydraulics, Keller Laboratories Instron. August 2016, August 2020.

SPONSORED STUDENT CLASS DESIGN AND BUILD PROJECTS

Ottawa Area Center, Allendale, MI, Motorization of Adult Therapeutic Swing, June 2011, June 2012, June 2014, June 2015, June 2016, June 2017
Grand Rapids Children's Museum, Grand Rapids, MI, Design of a Conveyor System, June 2012
Kent Area Intermediate School District, Design of a Portable, Flexible Stationary Bicycle Support, June 2012
Ottawa Area Center, Allendale, MI, Design of a Therapeutic Pool Support, June 2014
MotorGuide, Ada, MI, Design of a Trolling Motor Lift Mechanism, June 2014
MotorGuide, Ada, MI, Design of a Manual/Automatic Foot Pedal for a Trolling Motor, June 2014
Helix Corporation, Grand Rapids, MI, Optimization Analysis of a Concrete Reinforcement Twisting Machine, June 2014
Vanguard, Grand Rapids, MI, Design of a Floor Finish Removing Machine, June 2014
Fluition, Grand Rapids, MI, Design of a Sit-to-Stand Device, June 2014
Ottawa Area Center, Allendale, MI, Design of a Hugging Chair, June 2015, June 2016
Ottawa Area Center, Allendale, MI, Design of an Adult Bouncy Chair, June 2015, June 2017
Goodwin Performance, Zion, IL, Design of an Adaptive Performance Snowmobile Seat Suspension, June 2015
Ottawa Area Center, Allendale, MI, Design of a Cycle for Individuals Over 250 lb, June 2016, June

2017

Kent Area Intermediate School District, Design of a Slide Elevator, June 2016 GVSU EMC Center, Design of a Non-metallic 2-Axis Turntable, June 2016

Accessiblity Consultants, Design of a Movable Bocci Ball Ramp, June 2017

GVSU EMC Center, Design of a Plastic, 2-Axis Positioner for EMC Testing, June 2017

Jumping Jack Ski Seat, LLC, Kennedy Hall. April 2019

Blox, Experimental and FEA Modeling of Repurposed Shipping Containers. October 2021