

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DYSON TECHNOLOGY LIMITED AND DYSON, INC.,
Petitioners,
v.
OMACHRON INTELLECTUAL PROPERTY INC.,
Patent Owner.

Case No. IPR2024-00670
U.S. Patent No. 8,607,407

**Declaration of Amos Winter, Ph.D. in Support of
Patent Owner's Response**

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I, Amos Winter, declare as follows:

1. My name is Amos Winter. I have been retained by the Patent Owner to offer technical opinions related to U.S. Patent No. 8,607,407 (“the ’407 Patent”) (Ex. 1001). I understand that Petitioners are requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) has instituted *inter partes* review (“IPR”) of the ’407 Patent.

2. In this Declaration I give my opinions as to whether the claims of U.S. Patent No. 8,607,407 (“the ’407 Patent”) are valid. I provide technical bases for these opinions as appropriate.

3. This Declaration contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses. I make this Declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

I. BACKGROUND

A. Qualifications

4. I am over the age of 18 and am competent to write this Declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein. This Section contains a summary of my educational background, career history, publications, and

other relevant qualifications. My full *curriculum vitae* is attached as Appendix A to this declaration.

5. As shown in my *curriculum vitae*, I have over 20 years of experience as a practicing engineer and a professor teaching in the fields of mechanical design and product design.

6. I received a Bachelor of Science degree in Mechanical Engineering in 2003 from Tufts University. I received a Masters in Mechanical Engineering in 2005 from the Massachusetts Institute of Technology. I received a Ph.D. in Mechanical Engineering in 2011 from the Massachusetts Institute of Technology.

7. Over the past two decades, I have worked on numerous projects focused on mechanical design and product design in both academia and industry. My Ph.D. research focused on creating robotic systems for burrowing into underwater soils, primarily for anchoring applications. I partnered with an underwater robotics manufacturer, Bluefin Robotics, and the defense contractor Battelle on this project. Razor clams, *Ensis directus*, provided the basis of a bio-inspired robotic burrowing technology I invented called RoboClam. Like a razor clam, RoboClam was able to burrow with energy scaling linearly with depth, rather than depth squared for a blunt body moving through static soil. RoboClam technology resulted from gaining a fundamental understanding of the fluid, solid, and soil mechanics behind razor clam burrowing – principles that were successfully utilized for the creation of the robot.

This work resulted in multiple publications and RoboClam technology was subsequently licensed by Bluefin Robotics.

8. As a Ph.D. student, I also spent significant time designing wheelchairs for developing countries. I also taught an MIT course on developing world wheelchair design for four years as a Ph.D. student. Through these activities, I interacted extensively with the assistive device community and worked on the design of many assistive devices ranging from wheelchairs to tricycles to products to help people with disabilities earn an income. I led the development, and am the principal inventor, of a product called the Leveraged Freedom Chair (LFC) wheelchair. I conducted field pilots of the LFC in East Africa, Guatemala, and India. The LFC eventually became the basis of a wheelchair company I co-founded, Global Research Innovation and Technology (GRIT). GRIT produced over 2000 LFCs for the developing world, and now profitably sells a US market version called the Freedom Chair. The Freedom Chair is an approved product by the US Dept. of Veterans Affairs, is available for use in many national parks, and is the official wheelchair of the obstacle course competition Spartan Race. The LFC was the basis of “Engineering Reverse Innovations”, an article I co-authored and published in Harvard Business Review (HBR) about designing products for developing and emerging markets. In 2016 this article won the McKinsey Award for the best HBR article of the past year.

9. Since joining MIT's faculty, all my research activities have occurred at the interface of mechanical design and product design, and all are directed at solving real-world, applied problems. Most of my lab's projects are conducted in collaboration with market leaders in the target product spaces for our technology. For example, we have worked extensively with Toro, a market leader in irrigation technology, to design improved drip irrigation emitters. Our emitters require about 68% less pressure to deliver the required flow rate compared to existing products. This pressure reduction cuts pumping power, and thus energy cost, in a drip irrigation system by about 50%. Our technology facilitates affordable solar-powered drip irrigation systems that cost up to 40% less than current offerings. Our drip emitters are also half the size as current products, cutting material and shipping costs. The realization of our designs occurred by fundamentally understanding the fluid control mechanics of drip emitters to optimize them for smaller size and lower pressure. Toro is in the process of commercializing our drip emitters, and we have published many papers on how they are designed. My group has also advanced the technology behind entire drip irrigation system design and operation by using low-cost sensors and machine learning to predict soil moisture and tune irrigation water delivered to minimize wastage while maximizing crop productivity. Our recent irrigation system field pilots run in Jordan and Morocco have demonstrated approximately 40% reduction in water and energy use compared to traditional

irrigation practice. This energy reduction translates to a 30% decrease in the power system cost for solar-powered drip irrigation. We are currently creating productized versions of this technology that will be piloted throughout the Middle East and North Africa in partnership with USAID and Toro.

10. My research group also has a large portfolio on low-cost brackish water desalination systems. We have designed community-scale, solar-powered electro dialysis systems that hit price-parity with grid-powered reverse osmosis, despite the solar power system cost, and cut water wastage by 3 to 4X. Most of this work has been conducted in partnership with Veolia, the market leader in manufacturing electro dialysis systems. We are currently extending our desalination technology into applications that include desalinated water for irrigation, municipal-scale systems, and brine remediation for produced water from the oil and gas industry. I am launching a company with three members of my lab on this portfolio of technology, called Kira. My group has also worked extensively over the past seven years with the market leader in home-scale desalination systems in India, called Eureka Forbes. Together, we have advanced the state of technology for small, low-cost, low water wastage, electro dialysis-based desalination systems. Our desalination portfolio has required deep understanding into the fluid flow and electrochemical relationships behind electro dialysis, a topic on which we have published extensively, as well as rigorous product design to ensure the products we

create meet market-driven requirements related to form, function, reliability, and cost.

11. Additional research projects to create commercial products in collaboration with market leaders have included: BASF and Jain Irrigation, in addition to Toro, for drip irrigation products; Xylem for low-cost water pumping solutions for solar-powered irrigation; Tata Projects, in addition to Veolia, for desalination; Mahindra for the design of small-scale tractors; Jaipur Foot and Vibram for the design of high-performance, low-cost prosthetic feet for the developing world; and Ferrari for the design of hybrid transmissions.

12. I also regularly work as an engineering consultant on mechanical products and systems. Employers have included: Okuma for the design of fishing reels; Pepsi to instruct their R&D team on innovation and product design; and Sime Darby for the design of agricultural harvesting equipment. I also did a multi-year project with an Indian leader in consumer products, Usha, to design a higher flow and efficiency ceiling fan blade. I invented a low-cost, stamped aluminum blade shape that reduced drag and improved volumetric flow rate compared to Usha's existing offerings. Our design was eventually submitted for an Indian patent.

13. In July of 2023, my research group expanded into an MIT-wide center called the K. Lisa Yang Global Engineering and Research (GEAR) Center. The mission of GEAR Center is to strategically identify compelling challenges and

associated scientific knowledge gaps in resource-constrained communities, then address them through academic innovation to create and translate transformative technologies. GEAR Center is a convening entity for many MIT researchers to create physical devices through academic innovation that can positively impact resource-constrained communities. The initial thrusts of GEAR Center are the water-energy-food nexus, climate change mitigation and adaptation, and global health technologies.

14. I have co-authored a book, called Global by Design on how to design high-performance, low-cost products that create value in emerging as well as wealthy markets. The book includes many product design examples from companies around the world, as well as case studies on some of the projects from my own research listed above. The book will be published by Harvard Business Review Press in 2025.

15. My teaching is also focused on mechanical design and product design. I co-lead MIT's core, sophomore-level mechanical and machine design class 2.007 "Design and Manufacturing 1". In this class, each student makes a robot from scratch of their own conception, then competes in a two-day competition. I also teach a graduate-level machine and product design class focused on creating technologies for emerging markets, 2.76 "Global Engineering". This class works with many of the sponsors listed above. The class also always has multiple mechanical design

projects; recent partners and projects have included: Oshkosh for a mechanized trash collection device for roadway waste; Innovasea for a low-cost means of feeding multiple aquaculture fish pens; Eureka Forbes for a low-cost, low-water wastage home desalination system; Usha for an air conditioning system that uses desiccants to reduce power consumption; Mahindra on an electric version of their small Jeeto pickup; Tata Motors to reduce the noise, vibration, and harshness of the Tata Nano economy car; LV Prasad for low-cost vision enhancement systems for people with low-vision; Jaipur Foot for a new prosthetic knee design; Ferrari for concepts for hybrid, clutchless transmissions; the US Dept. of Veterans Affairs for a hydraulically damped prosthetic foot; and Boston Children's Hospital for the design of a low-cost warmer for phase change material baby warmers.

16. I have been involved in a variety of professional organizations over the years. I serve on multiple committees within the American Society of Mechanical Engineers and help execute all their programs focused on Engineering for Sustainable Development. I am a member of the Pi Tau Sigma and Tau Beta Pi honor societies. I serve as a reviewer for many journals that consider the mechanical design of products including the ASME Journal of Mechanical Design..

B. Compensation

17. For my efforts in connection with the preparation of this Declaration, I have been compensated at my standard rate for this type of consulting activity of

\$600 per hour. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

C. Materials and Other Information Considered

18. I have considered information from various sources in forming my opinions. I have reviewed and considered all exhibits listed in the attached Appendix B (Materials Considered) in forming my opinions.

II. UNDERSTANDING OF THE LAW

19. I am not an attorney. In forming my opinions in this Declaration, I applied the relevant legal principles provided to me by counsel, which are summarized in Appendix D.

III. TECHNOLOGY OF THE '407 PATENT

A. Overview of the '407 Patent

20. The '407 Patent discloses and claims novel designs for a hand vacuum cleaner which comprises at least one cyclone and at least one dirt collection chamber. The dirt collection chamber has an openable door positioned at the front end of the vacuum cleaner.¹ Abstract. The '407 Patent provided a solution to emptying a handheld vacuum cleaner through a novel approach of having a front openable door to a dirt collection chamber, so that there is no impediment to the door being opened, and further, so that when the vacuum cleaner is inclined or inverted to empty the

¹ Ex. 1001,

vacuum cleaner, no portion of the vacuum cleaner need be in front of the door, and accordingly, the dirt leaving the vacuum cleaner will not contact any portion of the vacuum cleaner when it is poured, e.g., into a garbage can.²

21. The '407 Patent has 4 independent claims (claims 1, 23, 24, 25). The limitations relating to the front door are as follows in claim 1:

(d) the cyclone and the dirt collection chamber having an openable door, the front wall comprising the openable door, whereby, when the door is in an open position, both the cyclone and the dirt collection chamber are opened.

Ex. 1001, cl. 1.

B. Priority Date

22. I have been asked to assume that the '407 Patent is entitled to claim priority to Canadian application No. 2658019, filed on March 11, 2010.

C. Challenged Claims

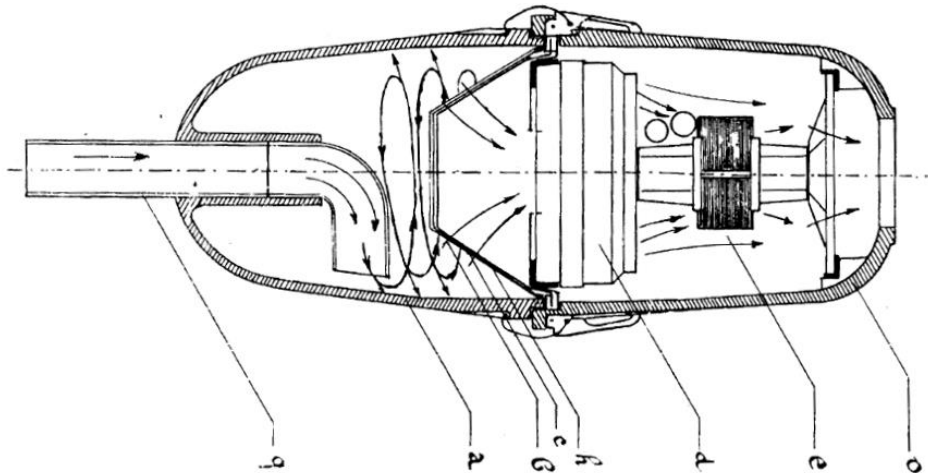
23. I understand that Petitioners are challenging the validity of claims 1–25 of the '407 Patent in the Petition for *Inter Partes* Review to which this Declaration will be attached. The claims being challenged are reproduced in Appendix C.

² Ex. 1001, 1:55–62.

IV. SUMMARY OF THE REFERENCES

A. PCT Publication No. 2007/084543 (“Martelliere”) (English Translation: Exhibit 1010)

24. Martelliere is a 1955 French patent for an improvement to a “broom type vacuum cleaner model” that addresses the “recognized difficulty” of emptying dust bags by “replacing fabric [dust] bags” with a container made of “smooth and transparent material.”³ This transparency allows a user to see how full the dust container is to “better judge when it must be emptied” and to “even see a lost object sucked up by the device and recover it.” *Id.*



Id., 2.

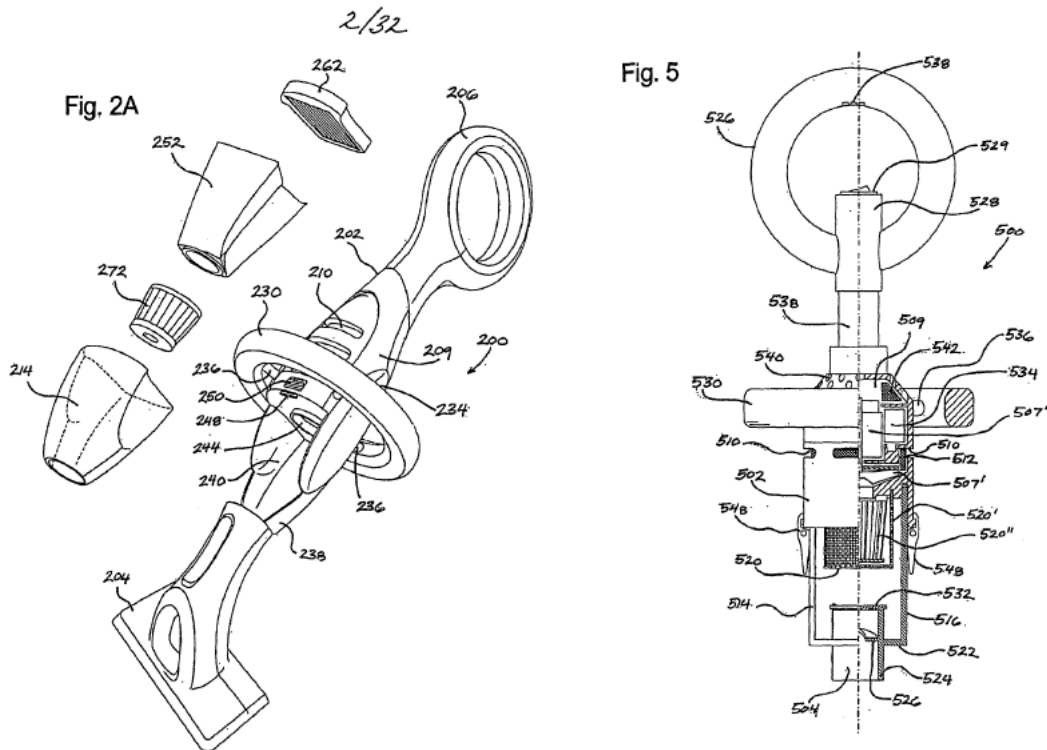
B. PCT Publication No. 2007/084543 (“Butler”) (Exhibit 1020)

25. Butler is a 2007 PCT publication that details several distinct embodiments of a specialized “Stair Cleaning Vacuum.”⁴ Title. Butler discusses

³ Ex. 1010, 1.

⁴ Ex. 1020,

various existing solutions such as “upright and canister vacuum cleaners,” “stick vacuums,” and “compact hand-held vacuums,” and concludes that there “exists a need for an improved vacuum cleaner” specifically adapted for cleaning “raised” surfaces, and “particularly stair treads and risers.”⁵ Two distinct embodiments from Butler—one associated with Figure 2A and the other with Figure 5—are shown below.

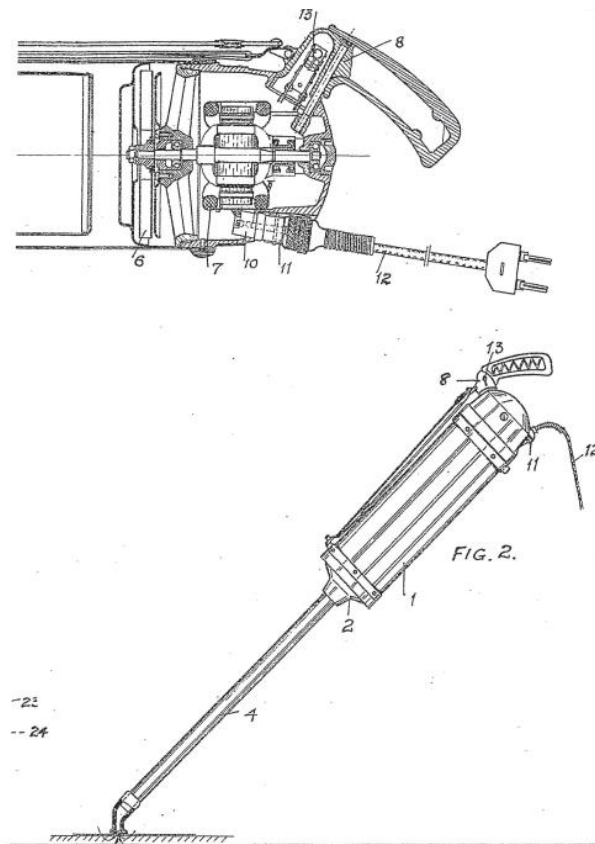


Id., Figs. 2A, 5.

⁵ *Id.*, 1:5–24, 3:10–16.

C. U.K. Patent No. GB283,179 (“IPVG”) (Exhibit 1006)

26. IPVG is a 1928 UK patent directed to a stick vacuum cleaner having an “enclosed dust bag” that protects the user from “accidental contact with current carrying parts” of the vacuum, such as the “securing means for the handle.”⁶ IPVG describes a “one-piece insulating cover adapted to cover the handle,” including a conductive screw that secures the handle to the casing of the vacuum cleaner.⁷



Ex. 1006, Fig. 2.

⁶ Ex. 1006, 1:10–21, 1:34–41.

⁷ *Id.*, 1:34–41.

D. U.S. Patent Publication No. 2008/0189901 (“Conrad335”) (Exhibit 1005)

27. Conrad335 is a 2007 U.S. patent application publication describing an upright vacuum with “a cyclone separator” having a cyclone chamber divided by a plate into “an upper cyclone chamber and a lower dirt collection chamber.”⁸ The cyclone chamber and dirt collection chamber are “removable as a closed unit from the vacuum cleaner” and, once removed from the body of the vacuum cleaner, can be emptied through an “openable bottom.”⁹ The disclosed cyclonic separator is generally upright orientation, with the dirt collection chamber positioned beneath the cyclone chamber.¹⁰

⁸ Ex. 1005, ¶¶4, 23.

⁹ *Id.*, ¶98.

¹⁰ *Id.*, ¶4.

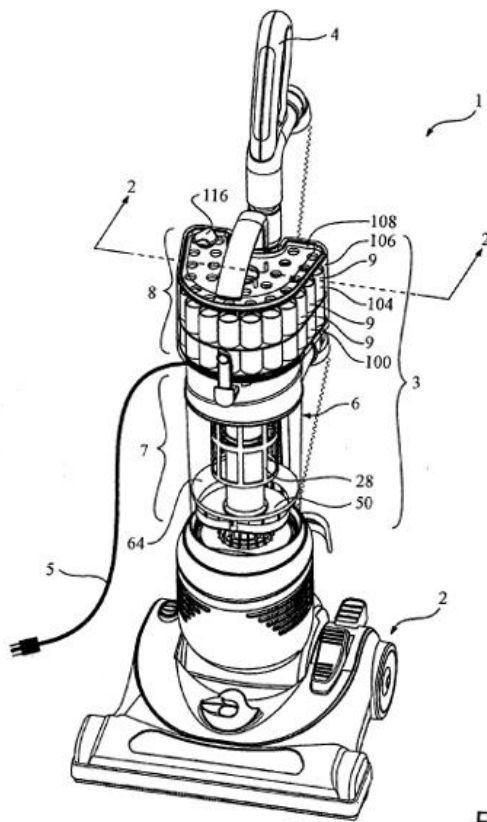


Fig. 1

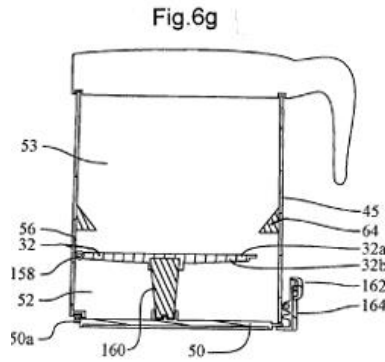


Fig. 6g

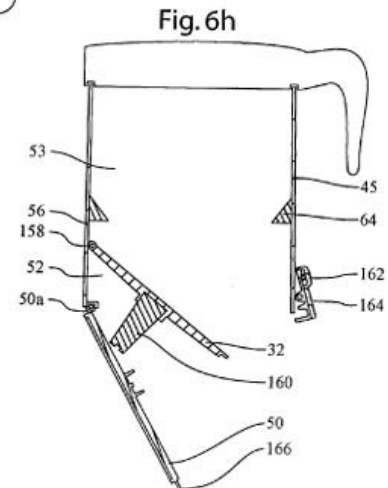
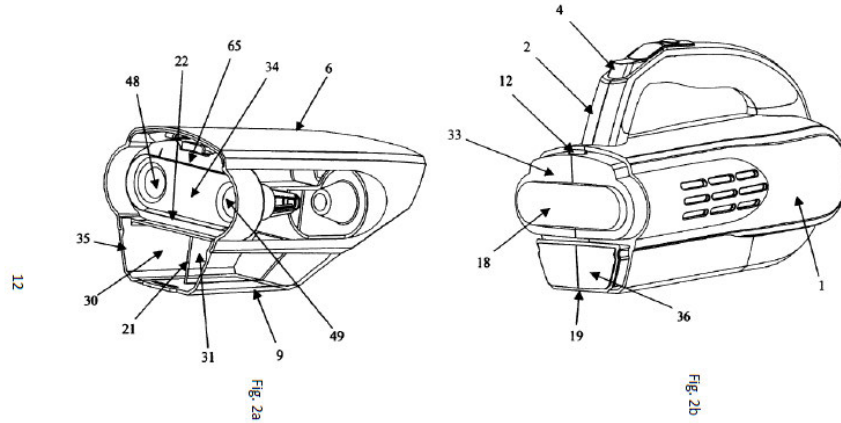


Fig. 6h

Figs. 1, 6g, 6h.

E. Chinese Patent Publication No. 101,061,932 (“Jianan”) (English Translation: Exhibit 1013)

28. Jianan is a 2007 Chinese patent application publication describing a “handheld vacuum cleaner” with a “detachable dust cup” “connected to the cyclone body through the dust release hole.” Ex. 1013, Abstract.



Id., Figs. 2a, 2b.

F. U.S. Patent Publication No. 2006/0156508 (“Khalil”) (Exhibit 1014)

29. Khalil is a 2006 U.S. patent application publication describing a “hand-held vacuum” with a “cyclonic flow chamber” and “rotatably detachable” “dirt cup” and “dirt cup door” located at the rear of the vacuum, with the suction nozzle in the front. Ex. 1014, Abstract.

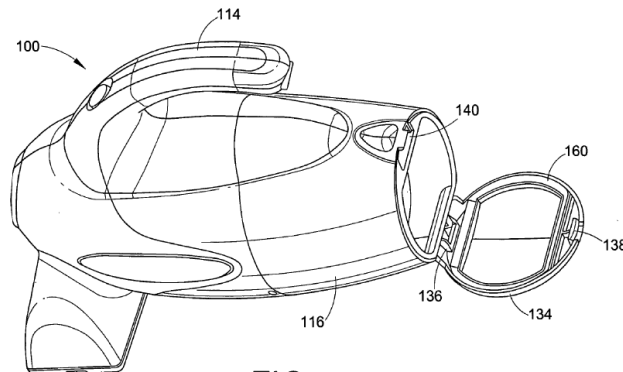


FIG. 7

Id., Fig. 7.

V. LEVEL OF ORDINARY SKILL IN THE ART

30. I understand that Petitioner has proposed that a person of ordinary skill in the art would have had a Bachelor’s degree in mechanical engineering, or in a

similar field and 2-3 years of experience in fluid dynamics and/or machine design for devices related to fluid dynamics, such as vacuum cleaners.¹¹ I understand that Dr. Giachetti has adopted this standard in his declaration.¹² I also understand that the Board adopted Petitioner's definition in its institution decision.¹³

31. For the purposes of this declaration, I accept this proposed level of ordinary skill in the art. I meet these criteria under the Petitioner's proposed level of skill. I consider myself to be a person with at least ordinary skill in the art pertaining to the '407 Patent at the time of this declaration's drafting. In addition, I was a person of at least ordinary skill in the art at the time of invention of the '407 Patent.

VI. CLAIM CONSTRUCTION

32. For purposes of this *inter partes* review, I have considered the claim language, specification, and portions of the prosecution history, to determine the meaning of the claim language as it would have been understood by a POSITA at the time of the invention in the '407 Patent. I have applied the plain and ordinary meaning to a POSITA, in view of the specification, of each of the terms in the claims of the '407 Patent. I understand that in instituting this IPR, the Board decided that

¹¹ Pet., 12.

¹² Ex. 1002, ¶ 41.

¹³ Instit. Dec., 7-8.

“no terms require explicit construction to resolve the issues presented by the arguments and evidence of record to reach a decision on institution.”¹⁴

VII. ANALYSIS OF THE GROUNDS

33. Based on my review and analysis of the materials cited herein, my opinions regarding the knowledge and understanding of a POSITA in the 2010 timeframe, and my training and experience, it is my opinion that a POSITA would have found the challenged claims valid in view of the references and combinations of references discussed below. The reasons for my conclusions are explained more fully below.

A. Ground 1: Claims 23–24 Are Not Anticipated by Martelliere

34. It is my opinion that Martelliere fails to disclose to a POSITA each and every element of claims 23–24 of the '407 Patent.

1. “openable door, the front wall comprising the openable door” [23d]/[24d]

35. It is my opinion that Martelliere fails to anticipate claims 23 and 24 , at least because it does not disclose limitations [23d]/[24d].

36. Petitioners and Dr. Giachetti identify the entirety of “container a” in Martelliere as “an openable door.”¹⁵ I disagree. This is not how a POSITA would interpret either Martelliere or the claimed “openable door.” “Door” by its plain and

¹⁴ Instit. Dec., 10.

¹⁵ Pet., 16–17; Ex. 1002 ¶¶ 94-99.

ordinary meaning, means a barrier that is swinging or sliding which can be opened or closed.¹⁶ For an “openable door” the ’407 Patent makes it clear to a POSITA that it refers to a door that is readily opened without other blocking parts or obstacles. For example, the ’407 Patent discloses that “one of the ends of the cyclone unit 114 may be openable. As exemplified in FIGS. 4 and 5A, in the example shown, front wall 158 is pivotably mounted to the cyclone unit wall 115 at pivots 177 and serves as an openable door 158 of the dirt chamber 124, such that dirt collection chamber 124 is openable, and dirt collection chamber 124 may be emptied.”¹⁷ A POSITA having read the Specification of the ’407 Patent would have readily understood that “openable door” is not a cover that must be unbolted, unscrewed, or removed in order to allow access to an entry.

37. The ’407 Patent does mention a “removable door,” and a POSITA would have understood that the door still needs to be pivotably or slidably mounted so that it can be readily opened. For example, with respect to Fig. 5b, the ’407 Patent discloses that “openable door 158 is removably mounted to cyclone unit wall 115. That is, openable door 158 may be removed from vacuum cleaner 100 by a user, and may be re-mounted to vacuum cleaner 100. Openable door 158 may be removably mounted by any means known in the art. For example, pivots 177 may be releasable

¹⁶ See Ex. 2001.

¹⁷ Ex. 1001, 7:14–20.

from door 158 or wall 115, or may be separable into two portions as shown. In alternate embodiments, a plurality of mechanical fasteners, such as latches 159, may be used.¹⁸

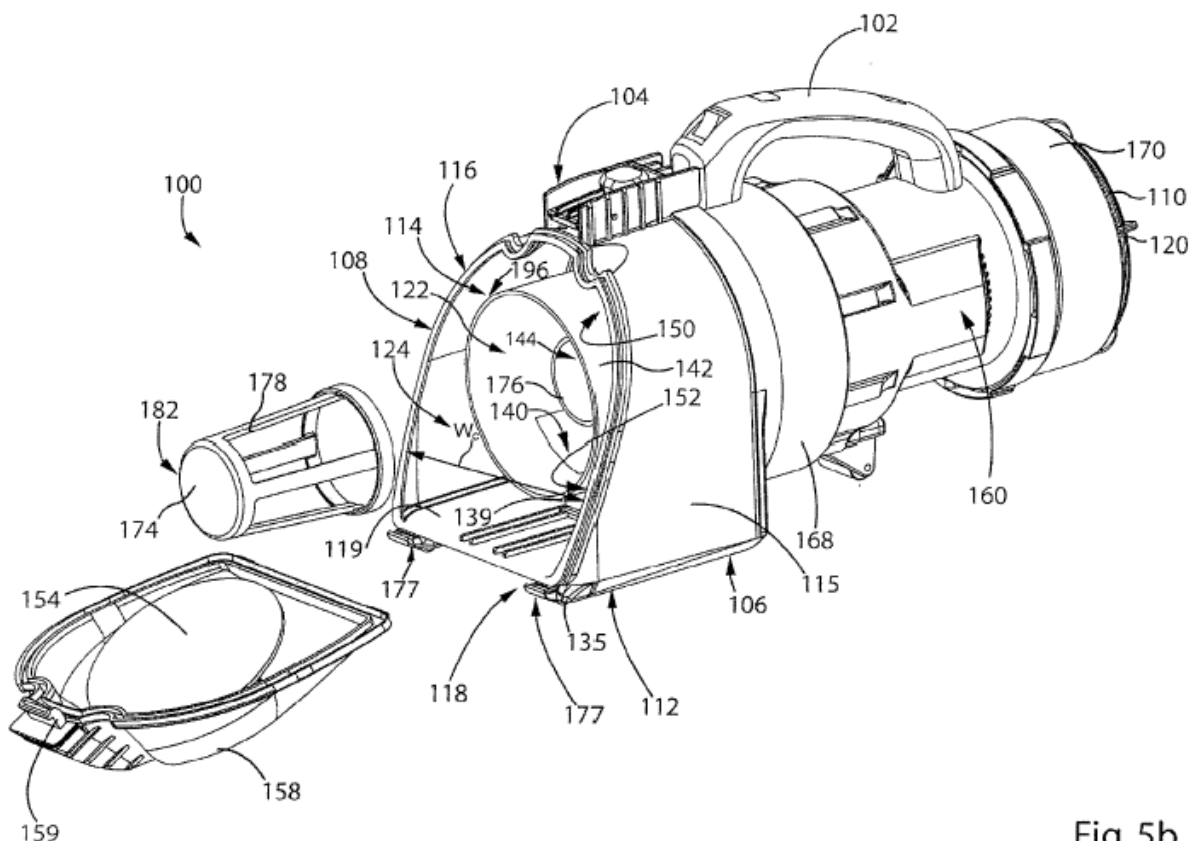


Fig. 5b¹⁹

And again, this is a door, not an entire container as Dr. Giachetti and Petitioners pointed to in the Martelliere.

38. Martelliere does not disclose an “openable door,” let alone one on a “front wall” to a POSITA.

¹⁸ Ex. 1001, 7:31–40.

¹⁹ Ex. 1001, Fig. 5B.

39. Martelliere seeks to improve on disadvantages of using “dust bags” for collecting dust and debris for a cyclonic separation device, including “difficulty” in emptying dust bags.²⁰ Martelliere’s alleged improvement is to replace the dust bags of the prior art with a container made of “smooth and transparent material.”²¹ Martelliere explains that its application of “Whirlwind” or cyclonic separation results in dirt being “deposited in the bottom of the container, after having separated from the air” and that this dirt can be emptied from the container with ease due to the smooth internal surface of the container.²²

40. Because the dirt collects on the bottom of the container, Martelliere states that the “container” (a in the figure, shaded in yellow) “is very easily detachable” for emptying.²³ At most, this suggests to a POSITA that the entire container can be detached and removed for emptying.²⁴ Nowhere does Martelliere describe its container as a “door,” let alone explain how it is an “openable door” on a “front wall.” Indeed, a container that is entirely removed (i.e., does not swing or slide) is not a “door” at all.

²⁰ Ex. 1010, 1.

²¹ *Id.*

²² *Id.*

²³ *Id.*

²⁴ *Id.*

41. Petitioners, through Dr. Giachetti, claim that container a in Martelliere is “pivotable” and that unlatching one latch allows the “‘container’ to pivot open.”²⁵ I disagree. This argument is entirely speculative and a POSITA would not have understood that this element is disclosed in Martelliere. Martelliere makes no mention of its container a being pivotable, and there is no evidence that opening just one of the latches will result in container a pivoting. For example, there may be more than two latches or the unopened latch may not be secure enough to allow container a to pivot about it.

42. Furthermore, even if the entire dust collection chamber were to pivot, that does not necessarily make the chamber a door. In the Challenged Claims, the “openable door” is a door to the dust collection chamber. What Dr. Giachetti is proposing, however, is that the dust collection chamber is an “openable door” to itself, which makes no sense to a POSITA in the context of the Challenged Claims.

2. Martelliere does not disclose that a “door is openable when the dirt collection chamber is mounted to the hand vacuum cleaner” [23f]

43. It is my opinion that Martelliere fails to anticipate claim 23, at least because it does not disclose limitation [23f].

²⁵ Pet., 16-17; Ex. 1002, ¶ 99.

44. I understand that Petitioners appear to argue instead that it is somehow possible for Martelliere’s “container a” to at once pivot open and remain mounted to metal frame f “through the other latch.”²⁶

45. Assuming that Petitioners mean to assert that the entirety of “container a” can pivot around one latch while disconnected from a second latch, container a would no longer be “mounted” to metal frame f of Martelliere and such operation is neither discussed nor contemplated by Martelliere. In other words, claim 23 specifies that “the door is openable when the dirt collection chamber is mounted to the hand vacuum cleaner.” Under Petitioners’ theory, the claimed “door” and “dirt collection chamber” are the same component—namely, “container a” of Martelliere. But it makes no sense—and Martelliere does not explain how it is possible—for container a to be simultaneously “mounted” (by one latch) to the metal frame and “openable.”

3. Martelliere does not disclose that an “openable door covers an end of the dirt collection chamber” [24f]

46. It is my opinion that Martelliere fails to anticipate claim 24, at least because it does not disclose limitation [24f].

47. Petitioners and Dr. Giachetti state, without support or explanation, that “Martelliere’s ‘container’ ‘wall’ (the openable door) covers the front end of ‘container a’ (the dirt collection chamber).”²⁷ This is not how a POSITA would have

²⁶ Pet., 17; Ex. 1002, ¶¶ 100-101.

²⁷ Pet., 17.

understood, as explained above. Petitioners have neither explained how what they have identified as Martelliere's "container wall" differs from Martelliere's container a, nor established how something can be argued to "cover[] the front end of" itself.

B. Ground 2: Claims 23-24 Are Not Anticipated by Butler

48. It is my opinion that Butler fails to disclose to a POSITA each and every element of claims 23–24 of the '407 Patent.

1. Petitioners improperly combine Butler's separate and distinct embodiments

49. Petitioners and Dr. Giachetti appear to be combining different embodiments from Butler's disclosure for this Ground. I understand that this is improper.

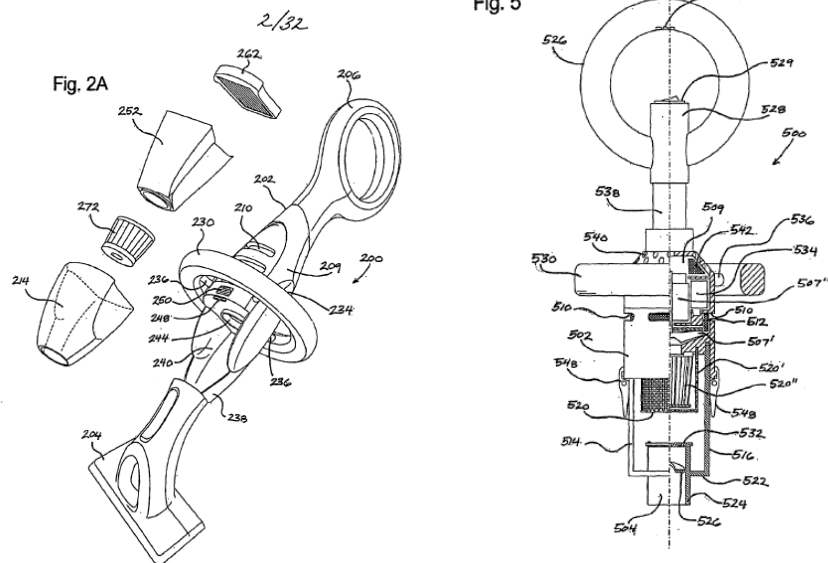
50. Each of Butler's Figs. 1, 2A–D, and 5 discusses a separate, independent embodiment of a stair vacuum cleaner (i.e., there are at least six different embodiments associated with these figures alone). See, e.g., For example, "Figure 1 is a perspective view of an embodiment of a vacuum cleaner of the present invention. Figure 2A is a perspective view of another embodiment of a vacuum cleaner of the present invention" ²⁸ Fig. 2B is a "view of a dust bag configuration," Fig. 2C is a "view of a dirt cup configuration," and Fig. 2C is a "view of a cyclone separator configuration." ²⁹ "Figure 5 is a partial cut away side view of still another

²⁸ Ex. 1020, 4:7–10.

²⁹ Ex. 1020, 4:11–16.

embodiment of a vacuum cleaner of the present invention.”³⁰ Also the examples are throughout Butler.³¹ Most relevant here, these separate embodiments have different dirt receptacles.

51. POSITA would have readily recognized that these figures are directed to different embodiments of the vacuum body shapes. For example, a POSITA would compare and contrast Fig. 2A and Fig. 5 and see them as different embodiments:³²



³⁰ Ex. 1020, 4:21–22.

³¹ *Id.*, 7:14–21, 15:19–20, 17:1–2, 17:15–16, 18:3–5, 20:3–4.

³² Compare *id.*, 16:14–15 (“dirt receptacle 214 . . . is shaped and sized to be selectively positionable in the pocket 240”), with *id.*, 21:8–9 (“cylindrical dirt receptacle 514 is removably attached at a bottom end of the housing 502”).

52. In particular, when discussing elements [23d]/[24d], Petitioners combine discussion of Butler's Figure 2 embodiments with discussion of Butler's Figure 5 embodiment. For example, in the very same sentence, Petitioners point to the alleged "chamber emptying" feature of "dirt receptacle 214," which is a component of the Figure 2A embodiment, and the alleged "removab[ility]" of "bottom wall 522," which is a component of the Figure 5 embodiment.

2. No embodiment in Butler discloses the claimed "openable door, the front wall comprising the openable door" [23d]/[24d]

53. It is my opinion that Butler fails to anticipate claims 23 and 24 , at least because it does not disclose limitations [23d]/[24d].

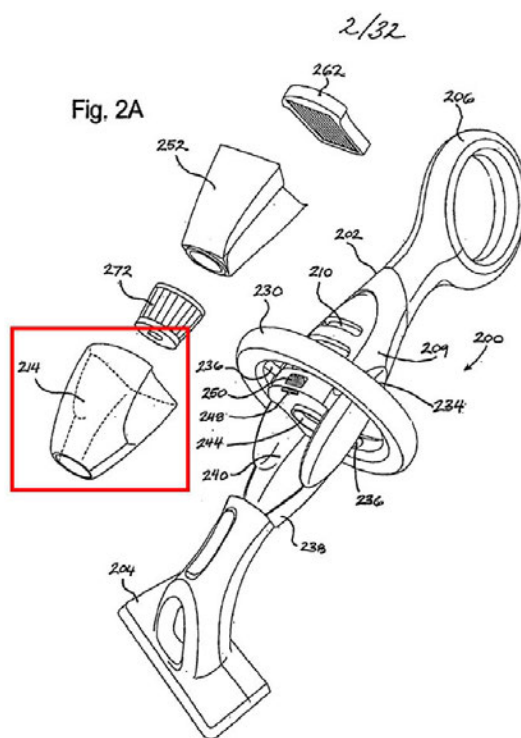
54. A POSITA would understand that neither the Figure 2 embodiments nor the Figure 5 embodiment disclose the claimed "openable door, the front wall comprising the openable door."

55. In the Figure 2 embodiments, the vacuum cleaner includes "dirt receptacle 214" (in red below).³³ Petitioners and Dr. Giachetti quote disclosure from Butler that "'dirt receptacle 214 may be covered by an access panel or door' to 'facilitate the chamber's emptying.'"³⁴ A POSITA having read Butler would see that Butler does not suggest or disclose anywhere that a front wall of the dirt

³³ Ex. 1020, 16:14–15.

³⁴ Pet., 22 and Ex. 1002, ¶¶ 127-30 (quoting Ex. 1020, 18:26–30).

receptacle would comprise such a door. Moreover, the disclosure regarding a “door” to “facilitate the chamber’s emptying” relates to an embodiment in which “dirt receptacle 214” is “omitted and replaced by a non-removable chamber within the housing.”³⁵ In that instance, there could not be a “door” on the front wall of the chamber because the chamber would be connected to the air inlet passage coming from inlet nozzle 204.



Id., Fig. 2A (annotated).

56. The Figure 5 embodiment likewise does not disclose the claimed “openable door, the front wall comprising the openable door.” Petitioners point to

³⁵ Ex. 1020, 18:27–28.

“bottom wall 522” in Butler, which Butler states is “removably attached to the sidewalls 516 by threaded engagement, bayonet fittings, clamps, screws, or the like.”³⁶ Petitioners quote Butler that “bottom wall 522” is “removable from the device,”³⁷ but for the reasons explained above, simply being “removable” does not make bottom wall 522 a “door.” As explained above, a POSITA would have understood that a “door” swings or slides to open; a door is not something that must be entirely removed to open.

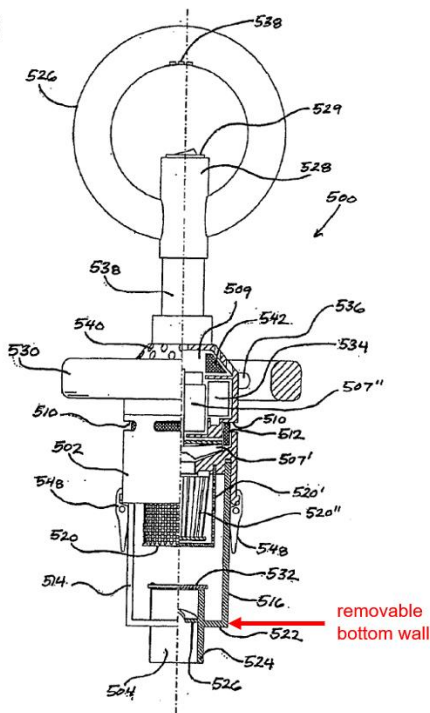
57. Petitioners and Dr. Giachetti never argue that bottom wall 522 is pivotable or slidable (as opposed to completely removable). Because it is fully removable, and not a swinging or sliding barrier, bottom wall 522 cannot be the claimed “openable door.”

³⁶ Ex. 1020, 21:19–23.

³⁷ Pet., 22; Ex. 1002, ¶¶ 127-30.

5/32

Fig. 5



Id., Fig. 5 (annotated).

C. Ground 3: Claims 1–25 Are Not Rendered Obvious by IPVG In View Of Conrad335

58. It is my opinion that IPVG In View Of Conrad335 fails to teach to a POSITA each and every element of claims 1–25 of the '407 Patent.

1. Petitioner Fails to Show a Motivation to Combine IPVG and Conrad335, and Then to Modify It, in the Way the Claims Require

59. It is my opinion that Combining IPVG and Conrad335 without Petitioners' significant unsubstantiated modifications would at a maximum lead to a configuration that is similar to Dyson's PCT Publication WO2008/009890 (EX2003). But what Petitioners and Dr. Giachetti are proposing further includes

significant modifications, which at least including that upright cyclonic separator with a bottom door (such as in Conrad335 or Dyson's PCT Publication WO2008/009890) should be turned by 90 degrees to create a front door.

60. Conrad335 as a POSITA would have understood, is directed to an upright vacuum which has a detachable upright cyclonic separator, and is exclusively focused on the design of a plate "positioned intermediate the opposed ends (the top end and the bottom end)" that separates a cyclone chamber on top and a dirt collection chamber beneath the cyclone chamber.³⁸

61. In contrast, IPVG discloses a dust bag type vacuum and its explicit objective is "to provide an apparatus of the above type with a handle ... so that the operator on holding the same during manipulation of the apparatus may be fully protective against accidental contact with current carrying parts of the apparatus."³⁹

62. As reiterated multiple times in IPVG, the handle and casing as disclosed in IPVG is "to render the operator completely safe from contact with current carrying parts of the apparatus."⁴⁰ IPVG thus offers no motivation to modify the vacuum's dirt separation method or air pathways in a way that could affect the inherently designed electrical wirings, for safety.

³⁸ Ex. 1005, ¶4.

³⁹ Ex. 1006, 1.

⁴⁰ Ex. 1006, 1.

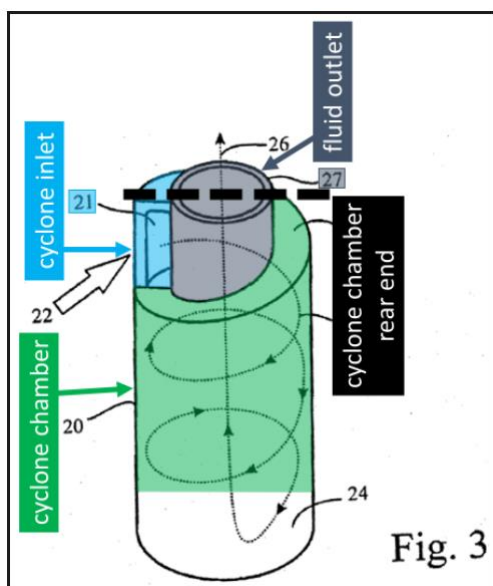
63. Petitioners cite to one paragraph of Conrad335 that the cyclonic separators “may be used ... to create ... a stick vacuum” or “a hand vacuum.”⁴¹ . But as a POSITA would have understood, none of the embodiments of cyclonic separators disclosed in Conrad335 has a front openable door, and every embodiment disclosed in Conrad335 is a cyclonic separator with an upright orientation with a bottom openable door. Conrad335 provides no motivation to rotate the cyclone by 90 degrees. And Petitioners did not cite to any teachings in Conrad335 to rotate the cyclonic separator. In fact, because it is so clear that Conrad335 contemplates a plate positioned intermediate between “the top end and the bottom end” of the cyclonic separator, a POSITA would have understood that Conrad335 does not intend to make any rotational changes to the cyclone.⁴²

64. Even a POSITA were assumed to be replacing the dust bag separation apparatus of IPVG with Conrad335’s cyclonic separator, he/she would have incorporated the cyclonic separator with an upright orientation. Further, as Petitioners and Dr. Giachetti agree, Conrad335 discloses that the air inlet and air outlet to be on the same end.⁴³

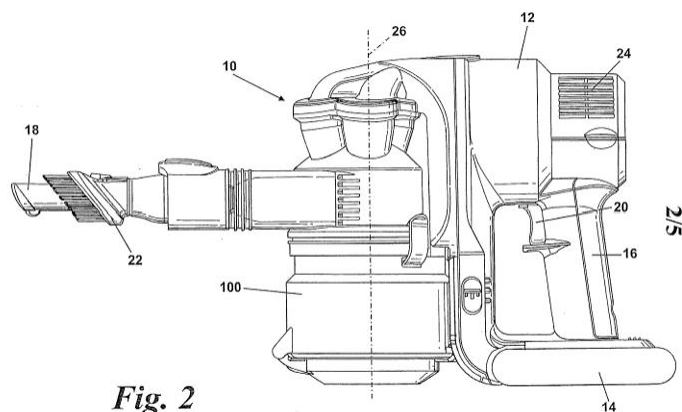
⁴¹ Pet., 29-30; Ex. 1002, ¶ 149-53, citing Ex. 1005, ¶376.

⁴² Ex. 1005, ¶ 4.

⁴³ Pet., 52vg-53; Ex. 1002, ¶¶ 223-24.



Ex. 1003, Fig. 3 (annotated by Petitioners, restored to the original orientation). Given that IPVG requires a “suction pipe 4” that leads air to the separator’s air inlet, the upright orientation of the cyclonic separator is more conducive to attaching such suction pipe. The end result of such substitution is therefore a vacuum with a handle and a motor at the rear end, and an upright cyclonic separator with an openable bottom door. However, the ’407 Patent on its very first page admits that this is in the prior art and is the starting point of the ’407 Patent’s disclosures.



EX2003, Fig. 2.; see Ex. 1001, 1:23-33. The stated objectives of the '407 have not been solved by this combination, i.e., “so that there is no impediment to the door being opened, and further, so that when the vacuum cleaner is inclined or inverted to empty the vacuum cleaner, no portion of the vacuum cleaner need be in front of the door, and accordingly, the dirt leaving the vacuum cleaner will not contact any portion of the vacuum cleaner when it is poured, e.g., into a garbage can.”⁴⁴

65. Petitioners identified no contemporaneous or prior evidence of any front door to a cyclonic separator. Neither Conrad335 or IPVG or any prior art admitted in the '407 Patent even attempts the kind of solution that the '407 Patent discloses—no cited prior art teaches using an openable door on the front wall.

66. Petitioners provided an alternative modification of replacing IPVG's “screwed cover 2” with Conrad335's bottom door.⁴⁵ This modification presents a totally different combination and modification than what Ground 3 of the Petition proposed for the rest of the elements, i.e., incorporating a cyclonic separator from Conrad335 and rotating it by 90 degrees. I understand that this is improper. Further, simply substituting the screwed cover of IPVG with the door of Conrad335 creates a combination that does not have a cyclone (therefore failing at least elements [1c]/[23c]/[24c]/[25c]). Further, a POSITA would wonder how the “suction pipe 4”

⁴⁴ Ex. 1001, 1:55–62.

⁴⁵ Pet., 39 and 47.

attached to the original “screwed cover 2” is to be placed with respect to the openable door from Conrad335.

67. Further, the Petition failed to address how the “suction pipe 4” attached to the original “screwed cover 2” is to be placed with respect to the openable door from Conrad335. A POSITA would have understood that adding the suction pipe directly on the modified “front door” would exert great torque stress on the door hinge, leading to flimsy opening and closing of the door as well as short longevity of the door hinge. Alternatively, rerouting the suction pipe would further add weight to the handheld vacuum, create more bends in airflow, leading to more suction loss.

2. Lack of a Reasonable Expectation of Success

68. It is my opinion that IPVG In View Of Conrad335 fails to render obvious claims 1, 12, 20, 28 and all dependent claims, at least because it does not teach limitations [1a.3]/[20a.3, 20e]/[12a.3]/[28a.3]. .

69. Here, Petitioner has identified a relatively low level of experience as being ordinary in the field—only a Bachelor’s Degree and two years of experience is required of POSITA.⁴⁶ See The challenges below would have been beyond such POSITA’s ability to reasonably resolve them.

70. Accordingly, POSITA would not have had the required reasonable expectation of success in extracting the cyclonic separator from the Conrad335

⁴⁶ Pet., 12; Ex. 1002, ¶ 41..

disclosed embodiments, rotating it, substituting the dust bag of IPVG, and make all other wiring and air flow changes.

71. The fundamental form factors of IPVG and Conrad335 are different (stick vacuum vs. upright canister) and they differ in shape, size, and dimension. Even if it were assumed that POSITA were motivated to combine IPVG and Conrad335's teachings —there would be substantial difficulties in doing so.

72. To take a cyclonic separator and incorporate it into a handheld stick vacuum requires far more work than just "simple substitution" as Petitioners and Dr. Giachetti claimed. A general aspiration by Conrad335 that a cyclone separator may be used in a stick or handheld vacuum does not mean that it is an easy substitution.

73. In order to make the change, the size of the cyclonic separator and air pathway have to be adjusted, and the fluid inlet and outlet must be adjusted with considerations to the suction loss introduced by narrower air passages, more frequent air bends, and the re-routing of hoses, turning the upright bases into a lightweight chasis, requiring a selection of efficient and lightweight motor, designing handles, balancing, selecting an energy-dense battery pack, adjusting wiring, ergonomics, etc.

74. Petitioners (Dyson) themselves spent 13 years between their first upright canister cyclonic vacuum and their first cyclonic handheld vacuum: Dyson's DC01, first cyclonic upright vacuum, was released in 1993; and Dyson's first handheld vacuum DC16 (which has a similar construction to the embodiments

disclosed in Ex. 2003) was released in 2006, thirteen years later. Ex. 2004. A process that took James Dyson and the Petitioners 13 years to complete and one that has been praised by media as one of “the British design deity’s most brilliant brainchildren” is not a swappable project to be completed by a POSITA with a bachelor’s degree and two years of experience with an expectation of success. See Ex. 2004.

75. On top of that, to arrive at the claimed configuration, further rotating the cyclonic separator’s orientation from upright to horizontal is required.

76. To a POSITA, making the changes to the airflow according to the embodiments of Conrad335 is not a trivial task. The entirety of flow path from inlet to the outlet of the vacuum has to be reconsidered to accommodate a front door. The redesign would also necessarily involve designing handles, balancing, selecting an energy-dense battery pack, adjusting wiring, ergonomics. Petitioners failed to address the motivation or the expectation of success for this modification. In any event, it took Dyson another twelve years to make this change, with its release of the V10, Dyson’s first handheld vacuum with a horizontal in-line cyclone and a front openable door.⁴⁷ Again, this is in line with industry expectations and definitely not

⁴⁷ See Ex. 2004.

a swappable project to be completed by a POSITA with a bachelor's degree and two years of experience with an expectation of success.⁴⁸

77. I understand that, in fact, Dyson was very proud of the feature of having an openable door on the front wall of the V10, and they applied for patents covering the feature and made marketing efforts highlighting this feature termed “point and shoot” for hygienic and ergonomic emptying.⁴⁹

78. It is my opinion that a POSITA would lack “a reasonable expectation of successfully achieving the claimed invention from the combination.

3. IPVG and Conrad335 Fail to Teach All Elements of the Claims

- a. “the dirt collection chamber having an openable door, the front wall comprising the openable door”
[1d],[23d],[24d],[25d]

79. It is my opinion that IPVG in View Of Conrad335 fails to render obvious independent claims 1, 23, 24, 25 and the dependent claims of the '407 Patent, at least because it fails to teach elements [1d],[23d],[24d],[25d].

80. As discussed, Petitioners assert that IPVG “teaches the dirt collection chamber having an openable door, the front wall comprising the openable door” because a “POSA would have understood IPVG's ‘screwed cover 2’ is a front wall comprising an openable door.” Pet., 44. But IPVG does not teach a dirt collection

⁴⁸ See Ex. 2004.

⁴⁹ See Ex. 2005 Ex. 2006, Ex. 2007.

chamber having an openable door on a front wall. Contrary to Petitioners' unsubstantiated assertions, a POSITA having read IPVG would have understood that the disclosed "screwed cover 2" must be unscrewed in order to be removed. A POSITA would not consider this an openable door. A removable cover that does not pivot or swing or slide is not an "openable door."

81. Conrad335 discloses a cyclone unit with a bottom door, and it does not disclose such an openable door on the front end. Petitioners makes a significant modification to Conrad335's disclosure without explanation in the proposed combination, i.e., turning it by 90 degrees. As discussed above, even if a POSITA were to incorporate a cyclonic separator according to Conrad335, the POSITA would have incorporated it into IPVG as disclosed: in a generally upright configuration.

82. A POSITA having read Conrad335 understands that the disclosure of Conrad335 is directed to "a plate positioned intermediate the opposed ends (the top end and the bottom end) of the casing of a cyclone separator" which is in a generally upright orientation, and that plate "divide[s] the interior of the cyclone casing into an upper cyclone chamber and a lower dirt collection area or chamber positioned beneath the upper cyclone chamber." Ex. 1005, ¶4. Incorporating this into IPVG to replace IPVG's dust bag, at most, would result in something that Dyson's PCT

Publication WO2008/009890 discloses, which is admitted as background prior art in the Introduction section of the '407 Patent.

83. As discussed further above, Petitioners also failed to demonstrate how a POSITA would be motivated to make this non trivial change of a 90 degree rotation and expect success.

b. “wherein the door is openable when the dirt collection chamber is mounted to the hand vacuum cleaner” [23f]

84. It is my opinion that IPVG in View Of Conrad335 further fails to render obvious independent claims 23 and the dependent claims of the '407 Patent, at least because it fails to teach element [23f].

85. For the same reasons discussed above for element [1b], IPVG does not disclose an openable door. Its “screwed cover 2” is not an openable door. The Petition claimed that the screwed cover is openable, but as a POSITA would have understood it, it is unscrewable to be removed, which is not “openable” as the claim requires.⁵⁰ Alternatively, Petition proposed to replace IPVG’s “screwed cover 2” with Conrad335’s bottom door.⁵¹ As discussed above, this is a different kind of combination and modification than what the Petition proposed for the rest of Claim 23, i.e., incorporating a cyclonic separator from Conrad335 and rotating it by 90 degrees. Simply substituting the screwed cover of IPVG with the door of Conrad335

⁵⁰ Pet., 46-47.

⁵¹ Pet., 47.

creates a combination that does not have a cyclone (therefore failing at least element [23c]).

c. claims 2-22

86. It is my opinion that IPVG in View Of Conrad335 further fails to render obvious dependent claims 2-22 for the same reason it fails to render obvious the independent claim 1.

D. Ground 4: Claims 23–24 Are Not Rendered Obvious by Martelliere In View Of IPVG

87. It is my opinion that Martelliere in View Of IPVG fails to teach to a POSITA each and every element of claims 23-24 of the '407 Patent.

1. A. Petitioners do not address each element of the Challenged Claims 23–24

88. Ground 4 only addresses elements [23pre]/[24pre] and [23d]/[24d]/[23f].⁵² Nowhere does Ground 4 purport to address or cite to any discussion of the remaining elements of the Challenged Claims 23–24. I understand that this is improper.

89. Nothing in the proposed combination of Martelliere and IPVG cures the issues described above with respect to neither reference disclosing an “openable door, the front wall comprising the openable door”—i.e., neither reference discloses a pivotally or swingably mounted door.

⁵² Pet., 73–77.

2. Petitioners failed to show that a POSITA would have been motivated to combine Martelliere and IPVG

90. Petitioners argue that “[a] POSA reading IPVG—including its teaching that a ‘dust bag or like member through which the air stream passes’ may be used as an air-filtration unit (Ex. 1006, 1:22-33)—would have been motivated to incorporate Martelliere’s teachings . . . for its many known advantages.”⁵³ In Ground 4, however, Petitioners’ alleged motivations to combine all relate to using IPVG’s stick vacuum with Martelliere’s cyclonic separation mechanism. Furthermore, Petitioners provide only statements about simple substitution and alleged advantages of modifying IPVG based on Martelliere’s disclosure without providing any explanation for such conclusory statements.

91. I disagree. To the contrary, a POSITA would find no teaching in either IPVG or Martelliere motivating the POSITA to make the combination. Petitioners and their expert depend on a generalized idea of replacing IPVG’s dirt bag with Martelliere’s whirlwind, but it still unclear how this combination is specifically to be made or how the combined system meets the claim.⁵⁴

⁵³ Pet., 74.

⁵⁴ Pet., 73-76.

E. Ground 5: Jianan in View of Khalil Does Not Render Obvious Challenged Claims 1–25

92. It is my opinion that Jianan in View of Khalil fails to teach to a POSITA each and every element of claims 1–25 of the '407 Patent.

1. Petitioners failed to show that a POSITA would have been motivated to combine Jianan and Khalil

93. Petitioners' Ground 5 fails from the start because Petitioners have not sufficiently demonstrated a motivation to combine Jianan and Khalil. Rather, Petitioners provide conclusory statements about simple substitution and alleged advantages of modifying Jianan based on Khalil's disclosure without providing any explanation for such conclusory statements. For example, Petitioners claim that "Jianan does not specify further implementation details for its dust-collection chamber's 'moveable door'" and a "POSA would have substituted Khalil's detailed dirt-cup door teachings of using an end-wall as a door, including its hinged door-opening mechanism."⁵⁵ Petitioners do not explain why a POSITA would have looked to Khalil's disclosure of a rearward opening dirt cup door to inform the design and placement of an "opening and closing device such as a door" of Jianan's removable dust collection chamber.

94. Although Jianan contemplates that "[a]nother opening device that replaces the dust collection chamber opening 35 can be a moveable door on the dust

⁵⁵ Pet., 78, 80–81.

collection chamber 9,” id., 10, Jianan provides no details or disclosure of where the door would be placed or how the door would be implemented.

95. If anything, because Jianan explains that dust collection chamber 9 is emptied through opening 35 in the rear,⁵⁶ an “openable door” in Jianan would be placed at the rear of dust collection chamber 9.

96. Petitioners present Jianan’s silence as its primary motivation to modify Jianan based on the disclosure of Khalil. Petitioners argue that “[a] POSA would have looked to references teaching implementation details for moveable doors on dust collection chambers in handvacs to enable Jianan’s goal of providing a ‘clean and convenient dust removal process,’” and that “Khalil is one such reference.” Pet., 80. This is not how a POSITA would have understood Jianan.

97. But even if this silence was a reason to select a door mechanism from the prior art or common knowledge, Petitioners failed to provide a reason why a POSITA would select Khalil’s implementation (using a hinge and the entire rear end-wall), rather than any other known mechanisms and/or placements to use in Jianan’s vacuum. Furthermore, Petitioners do not explain why Khalil’s rear-wall openable door would be moved to a “front wall” of Jianan (as opposed to a rear, side or bottom wall). In fact, as noted above, Jianan teaches that the dust collection chamber is emptied through “dust collection chamber opening 35,” which is in the

⁵⁶ Ex. 1013, 10.

rear of Jianan's dust collection chamber and faces towards the *rear* of Jianan's vacuum.⁵⁷ Thus, even if modifying Jianan in view of Khalil, a POSITA would have included a pivoting door on the rear of Jianan's dust collection chamber. Nothing in either Jianan or Khalil suggests placing an openable door on the front of the dust collection chamber.

98. Petitioners claim that, without extending the modified door to cover both the dirt collection chamber and the cyclone chamber, fibrous materials may wrap around the conical cyclone filters and must be pulled out manually.⁵⁸ But this challenged did not exist in Jianan to begin with. Jianan discloses a dust cup 6 which is part of the body that covers the entirety of both the cyclone chamber and the dirt collection chamber.⁵⁹ A POSITA would have understood that when emptying the dirt collection chamber, the dust cup 6 is removed, and any fibrous materials can be removed from the filters. This supposed issue of fibrous material is only introduced by Petitioners' hindsight-guided modification of introducing a door to the sidewall of the dirt collection chamber. In fact, this is one of the reasons why a POSITA would not have modified Jianan to begin with.

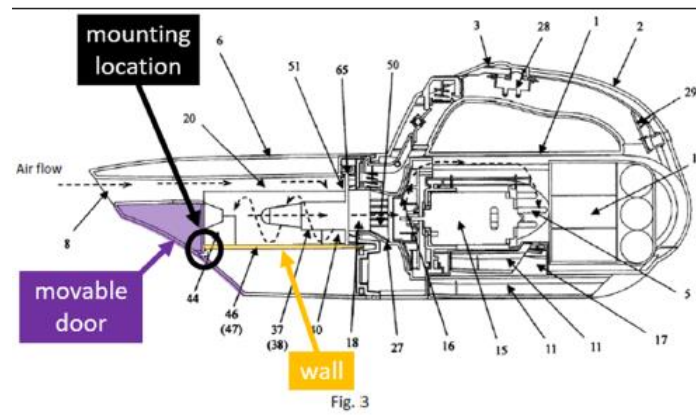
99. Furthermore, Petitioners' proposed combination of Jianan and Khalil has a door that is unopenable, non-pivotable, and therefore inoperable. With respect

⁵⁷ Ex. 1013, 10, Fig. 2a.

⁵⁸ Pet., 86.

⁵⁹ Ex. 1013, Figs 1 and 3.

to claim 6, Petitioners stated that the wall between the cyclone chamber and the dirt collection chamber according to Jianan should be mounted to the proposed “movable door” at the mounting location annotated:



Pet., 95; Ex. 1013 Fig.3 (annotated by the Petition). But this configuration, proposed by the Petitioners in order to read onto claim 6, is completely inoperable, as the long wall blocks any pivoted opening of the door.

2. The Jianan and Khalil combination does not render obvious claimed “openable door, the front wall comprising the openable door” [1d]/[23d]/[24d]/[25d]/[23f]/[24f]

100. It is my opinion that Jianan in View Of Khalil fails to render obvious independent claims 1, 23, 24, 25 and the dependent claims of the '407 Patent, at least because it fails to teach elements [1d]/[23d]/[24d]/[25d]/[23f]/[24f].

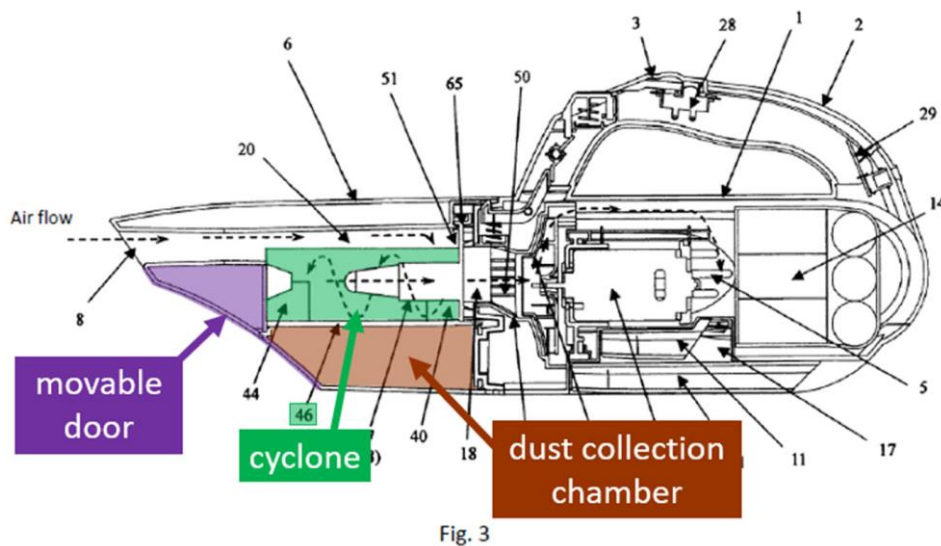
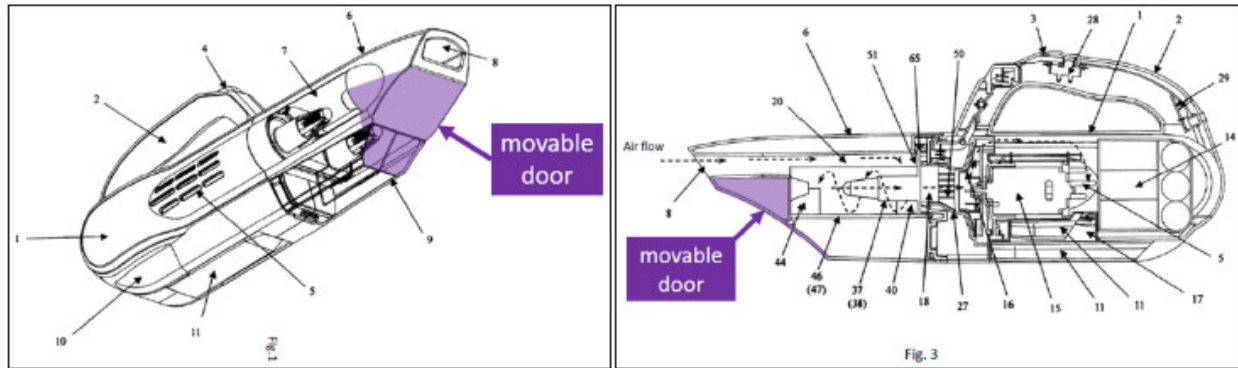
101. Petitioners allege that they would have been obvious over Jianan in view of Khalil. But Petitioners have failed to show that either of Jianan or Khalil discloses a “front wall comprising [an] openable door,” as required by all independent claims.

102. Jianan describes a “handheld vacuum” with a “detachable dust cup” “connected to the cyclone body through the dust release hole.”⁶⁰ Petitioners state that Jianan contemplates a “moveable door on the dust collection chamber,”⁶¹ but nowhere does Jianan state where on the dust collection chamber the moveable door is located. Petitioners attempt to identify where the “moveable door” would be positioned by pointing to portions of the sidewall of the main body of Jianan’s vacuum, as shown below in purple, not a “front wall.”

103. A POSITA, having read Jianan, would not have considered the part highlighted in purple here on the front wall. The proposed “door” extends in a plane that is more horizontal than vertical, and, in other words, the vector normal to that proposed “door” is more vertical, meaning the orientation of the entry way that the “door” covers is not a front entrance, but a bottom or side entrance. Further, the proposed “door” opens up to a significant nose space but not much of the cyclone chamber itself.

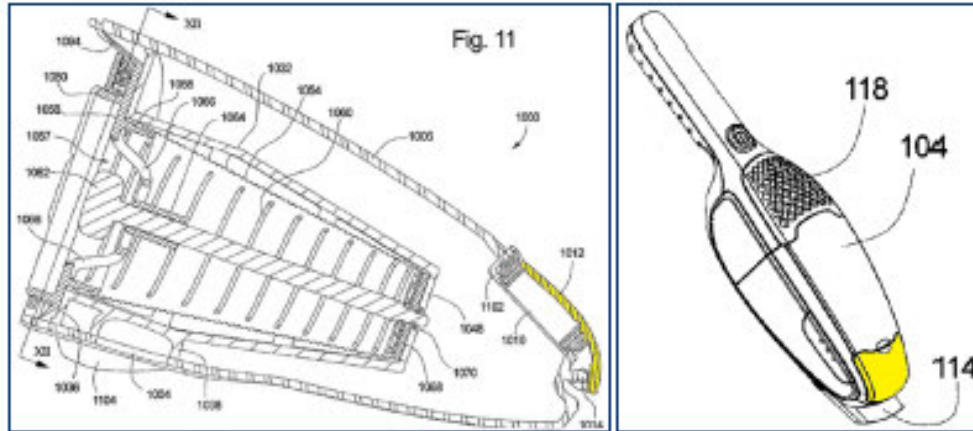
⁶⁰ Ex. 1013, Abstract.

⁶¹ *Id.*, 10.



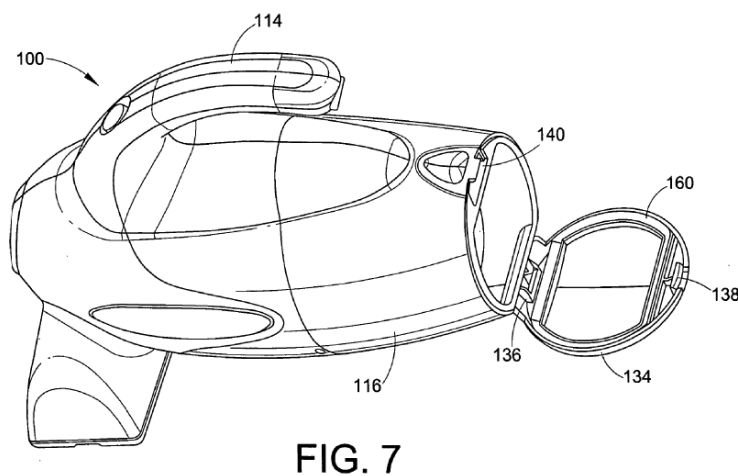
Pet., 81, 86 (as annotated in the Petition). This location is no different than that of Beskow (U.S. Publication No. 2008/0040883), discussed above, which Applicant successfully distinguished during prosecution as having a door on a “*sidewall* of the dirt collection chamber.”⁶² Thus, even accepting Petitioners’ interpretation of Jianan, a POSITA would not have considered it to disclose an “openable door” on a “front wall” of the vacuum cleaner.

⁶² Ex. 1004, 169–72, 217.



Ex. 1015, Figs. 1B, 11 (annotated).

104. Petitioners also seem to argue that “[a] POSA would have been motivated to implement Jinan’s [sic] moveable-door teachings using Khalil’s dirt-cup-door teachings and would have reasonably expected success.”⁶³ But, as discussed below, Khalil discloses a detachable “dirt cup” and “dirt cup door” located at the *rear* of the vacuum.⁶⁴



⁶³ Pet., 88.

⁶⁴ Ex. 1014, Abstract.

Id., Fig. 7. Khalil's disclosure of an openable door at the rear of a vacuum cleaner cannot cure the lack of disclosure in Jianan for an "openable door" on a "front wall."

3. The Jianan and Khalil combination does not render obvious Challenged Dependent Claims 2–22

105. It is my opinion that Jianan in View Of Khalil fails to render obvious independent claims the dependent claims of the '407 Patent, at least because it fails to teach independent claim 1, as discussed above.

106. Specifically, with respect to Claim 9, Petitioners alleged that a skilled artisan would have understood Khalil's "hinge" is secured to the handvac by a removable screw or pin, at least because Khalil appears to depict one in the center of Khalil's "hinge." Pet., 99. This is completely inventing a teaching that does not exist in either Khalil or Jianan.

107. Neither Khalil nor Jianan suggests or discloses a removable door or removable door hinge, nor can Petitioners cite to any portion of any references. Only support for this proposed modification of making the hinge removable, which is apparently guided by nothing but the claim itself, was Dr. Giachetti's naked assertion that the hinge of Khalil could be removed. Pet., 99.

108. with respect to claim 12, Petitioners alleged that a skilled artisan would have been motivated to “seal” Jianan’s dust collection opening.⁶⁵ This is completely inventing a teaching that does not exist in either Khalil or Jianan.

109. Neither Khalil nor Jianan suggests or discloses a dirt collection chamber as a sealed unit, nor can Petitioners cite to any portion of any references. Only support for this proposed modification of making the dirt collection chamber a sealed unit, which is apparently guided by nothing but the claim itself, was Dr. Giachetti’s naked assertion that the dirt collection chamber may be seal.⁶⁶

VIII. RESERVATION OF RIGHTS

110. My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the ’407 Patent that would render any of the challenged claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the Petitioners and to take into account new information that becomes available to me.

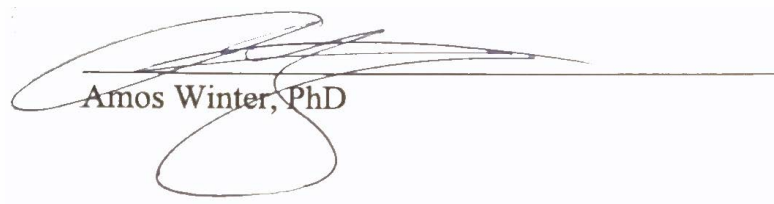
⁶⁵ Pet., 101-102.

⁶⁶ Pet., 101-102; Ex. 1002, ¶392.

I, Amos Winter, declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that willful false statements and the like so made could jeopardize the validity of the patent at issue in this proceeding.

Executed on December 11, 2024, in Abu Dhabi, UAE.

By:


Amos Winter, PhD

APPENDIX A: CURRICULUM VITAE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
FACULTY PERSONNEL RECORD

Date: September 16, 2024

Full Name: Amos G. Winter, V

Department: Department of Mechanical Engineering

1. Citizenship: United States

2. Education:

School	Degree	Date
Tufts University	Bachelor of Science	June 2003
Massachusetts Institute of Technology	Master of Science	June 2005
Massachusetts Institute of Technology	Doctor of Philosophy	February 2011

3. Title of Thesis for Most Advanced Degree: Biologically inspired mechanisms for burrowing in undersea substrates

4. Principal Fields of Interest:

Mechanical and product design; Assistive technology; Design for emerging markets and developing countries; International development; Reverse innovation and cross-cultural technology transfer; Biologically-inspired design; Fluid, solid, soil mechanics; Biomechanics; Medical device design; Water purification; Irrigation; Agricultural Equipment

5. Name and Rank of Other Department Faculty in the Same Field:

John H Lienhard, V, Professor

Sanjay E Sarma, Professor

Alexander H Slocum, Professor

6. Name and Rank of Faculty in Other Departments in the Same Field:

Charles H Fine, Professor, Sloan School of Management

Hugh M Herr, Professor, Program in Media Arts and Sciences

John Allen Ochsendorf, Professor, Department of Architecture, Department of Civil and Environmental Engineering

7. Non-MIT Experience (including military service):

Employer	Position	Beginning	Ending
Monterey Bay Aquarium Research Institute	Intern	June 2001	August 2001
NASA Jet Propulsion Laboratory	Intern	June 2002	August 2002
Bluefin Robotics	Intern	June 2003	August 2003
Schlumberger-Doll Research Center	Intern	January 2006	June 2006
Bluefin Robotics	Contractor	January 2006	June 2010

Employer	Position	Beginning	Ending
Indian Institute of Technology Delhi	Visiting Researcher - Supervisor: Prof. Sudipto Mukherjee	September 2010	June 2011
SUTD-MIT International Design Center (based in Singapore)	Postdoctoral Associate	October 2010	August 2011
Battelle Memorial Institute	Contractor	September 2011	June 2012
Global Research Innovation and Technology (GRIT)	Co-Founder, Chief Scientific Advisor	September 2011	-

8. History of MIT Appointments:

Title	Department	Beginning	Ending
Postdoctoral Associate	MIT-SUTD Collaboration	September 2011	June 2012
Assistant Professor	Department of Mechanical Engineering	July 2012	June 2017
Director, Global Engineering and Research (GEAR) Lab	Department of Mechanical Engineering	July 2012	-
Associate Professor without tenure	Department of Mechanical Engineering	July 2017	June 2019
Associate Professor with tenure	Department of Mechanical Engineering	July 2019	June 2024
Director, K. Lisa Yang Global Engineering and Research (GEAR) Center	School of Science	July 2023	-
Professor	Department of Mechanical Engineering	July 2024	-

9. Consulting Record:

Firm Name / Activity Description	Beginning	Ending
Massachusetts General Hospital, Worked with Dr. Timothy Bhattacharyya. Devised a non-invasive femur fracture criterion to predict bone stresses during hip replacement surgery. Developed a bone testing apparatus to measure bone fracture stress and verify the femur fracture criterion.	January 2006	January 2008
Global Research Innovation and Technology (GRIT), I serve as the Chief Scientific Advisor for GRIT and help the company with its technical and business activities.	September 2011	-
ASME Mechanical Engineering Magazine, I wrote a quarterly article in ME Magazine about engineering for global development.	November 2012	November 2013
Okuma Fishing, Machine design and product design for new saltwater fishing reels	October 2013	April 2014
Usha International Ltd, Designing high efficiency ceiling fan blades	November 2013	January 2016

Firm Name / Activity Description	Beginning	Ending
Smith & Nephew, Led a short course on designing products for emerging markets	February 2014	February 2014
PepsiCo, Led a short course on designing products for emerging markets	December 2015	December 2015
Sime Darby, Consulting project on new irrigation technique and mechanization solutions for palm plantations	July 2016	January 2021
InnovaSea Systems, Inc., Day-Long Workshop for Scientists and Engineers	November 2016	November 2016
Clear Council Law Group, Consulting on a legal case involving wheelchairs	July 2018	April 2022
Sunstein Kann Murphy & Timbers LLP, Served as an expert witness on an patent infringement case involving cochlear implant devices	September 2019	December 2023
Tuck School of Business, Dartmouth College, Executive Training, Led a short course on "Global by Design"	May 2021	May 2022
Quinn Emanuel, Serving as an expert witness on an infringement case relating to robot leg design	February 2024	-

10. Department and Institute Committees, Other Assigned Duties:

Organization / Activity Description	Beginning	Ending
MIT Graduate Resident Tutor in New House Residence	January 2005	January 2010
Tata Center for Technology and Design at MIT, Core Faculty	November 2011	August 2019
MIT MISTI, MISTI Global Seed Fund Grant Reviewer	January 2012	January 2012
Graduate Admissions Committee, Committee Member, Design Area Review Lead	February 2012	June 2015
Tata Center for Technology and Design Proposal Reviewer (Regular Member)	February 2013	August 2019
Tata Center for Technology and Design, Proseminar Speaker Series Co-Organizer	June 2013	August 2019
Tata Center for Technology and Design at MIT, Program Committee	June 2013	July 2019
Sports Technology and Engineering @ MIT (STE@M) Program, Member	June 2013	-
MIT@F1 "Innovation in Automotive Technologies", MIT networking and fundraising event held at the 2013 US Formula 1 Grand Prix in Austin, TX	October 2013	November 0013
iHouse, Faculty Advisory Committee, Committee Member	January 2014	July 2019
MechE Lincoln Laboratory Task Force (Regular Member)	January 2014	June 2019

Organization / Activity Description	Beginning	Ending
ME Dept DeFlorez Design Competition, Faculty Lead and Organizer	January 2015	July 2022
I started and run the "Inspiring Engineering Lecture" series, which showcases an accomplished individual who has created an engineering marvel and/or excited the general public about engineering. (Chair)	May 2015	-
MIT Formula SAE, Faculty Supervisor	September 2015	-
Abdul Latif Jameel World Water and Food Security Lab (J-WAFS) proposal reviewer (Regular Member)	January 2016	-
Behavioral Assessment and Response Team (BART) (Regular Member)	August 2018	-
Solar Car Team, Faculty Supervisor (Other)	January 2020	-
As charged by the President, the Sexual Misconduct Prevention and Response Committee is an advisory body that will provide guidance to the Provost, the Chancellor, the Vice President for Human Resources, and the Institute Community and Equity Officer as needed; to encourage a campus environment that is safe, respectful and free from discrimination; and to oversee an institute-wide approach to prevent and respond to sexual misconduct and other forms of gender-based discrimination.	July 2020	June 2023
Diversity, Equity and Inclusion (DEI) Task Force Member at Large (Other)	August 2020	July 2021
D-Lab Executive Director Search Committee (Regular Member)	December 2020	May 2021
Sexual Misconduct Prevention and Response, Committee on (Regular)	July 2023	June 2026
Morningside Academy for Design, Undergraduate Education Pillar (Co-Chair)	September 2023	-
11. Professional Service:		
Organization / Activity Description	Beginning	Ending
ASME, Engineering for Change Advisory Committee	January 2010	-
ASME, Engineering for the Developing World Summit	March 2010	March 2010
ASME, Engineering Global Development Committee	January 2011	-
RESNA, SIG-17 "International Appropriate Technology" Chair	January 2011	June 2013
Journal of Experimental Mechanics, Paper reviewer	2011	2011
ASME/NSF, NSF Workshop: Research in Materials and Manufacturing for Extreme Affordability (RIMMEA)	March 2011	March 2011

Organization / Activity Description	Beginning	Ending
ASME Journal of Mechanical Design, Paper Reviewer	2012	-
ASME, Created and co-organized Engineering for Global Development Forum, ASME IDETC/CIE (held in the Design Automation Conference)	November 2012	July 2019
Bioinspiration & Biomimetics, Paper Reviewer	2013	2013
ASME, Engineering for Global Development Conference Programming Committee	November 2013	-
Veteran's Affairs, RRD5- Rehabilitation, Review Panel	2014	2017
Elsevier, Development Engineering, Associate Editor	2014	2017
ASME, co-organized the Engineering for Global Development Impact Forum at ASME IMECE	January 2014	November 2014
Oregon State University, Humanitarian Engineering, Advisory Board Member	June 2014	-
Elsevier, Development Engineering, Paper Reviewer	2015	2023
ASME, Journal of Mechanisms and Robotics, Paper Reviewer	2015	-
Nature Physics, Paper Reviewer	2015	2015
IEEE, Transactions on Neural Systems and Rehabilitation Engineering, Paper Reviewer	2016	-
Department of Veterans Affairs, Rehabilitation Research and Development SPiRE Program, Application Reviewer	2016	2017
National Academies Committee to Review Science Technology Innovation and Partnership for Development: Implications for the Future of USAID, Committee member	June 2016	February 2017
ASME Mechanisms and Robotics Committee, Committee that plans the Mechanisms and Robotics (MR) Conference at the ASME International Design Engineering Technical Conferences (IDETC), Committee Member (six-year term)	August 2016	August 2022
The National Academies of the Sciences, Engineering, and Medicine, New Voices in Sciences, Engineering, and Medicine (SEM) Initiative, One of eighteen early career SEM leaders selected for the committee	2018	2020
ASME, Engineering for Global Development Stakeholder Summit, Breakout Group Facilitator	January 2022	January 2022
Tufts Mechanical Engineering, first advisory council , Board Member	March 2024	-

12. Awards Received:

Award	Date
Tufts Varsity Football Letter Winner	November 2001
Tufts Varsity Football Letter Winner	November 2002
Tufts Alex Elias Memorial Prize Scholarship	January 2003

Award	Date
Hugh Hampton Young Memorial Fund Fellowship	January 2007 - January 2009
MIT IDEAS Competition Winner, Award for International Technology for the Leveraged Freedom Chair	January 2008
ASME IDETC Conference, Graduate Student Mechanism Design Competition, 1st place for the Leveraged Freedom Chair	January 2009
ASME IDETC Conference, Robot Design Competition, 2nd place for RoboClam	January 2009
Fulbright-Nehru Student Research Fellowship to India (declined by Dr. Winter)	January 2010
R&D 100 Award for the Leveraged Freedom Chair, given by R&D Magazine for the 100 most technologically significant products of the year	January 2010
R&D 100 Editors' Choice Award for the Leveraged Freedom Chair, given to the three favorite R&D 100 award winners by the magazine's editors	January 2010
MIT School of Engineering Graduate Student Extraordinary Teaching and Mentoring Award, the highest honor given to a graduate student for teaching and mentoring at MIT	January 2010
ASME Innovation Showcase, 1st place for the Leveraged Freedom Chair	January 2010
Gold Award, Spark Awards for design, world changing category for the Leveraged Freedom Chair	January 2010
Finalist, Lemelson-MIT Student Prize	January 2010
Extraordinary Stories Award, National Academy of Engineering Grand Challenge Summit	January 2010
Wall Street Journal Big Innovations of 2011 (one of seven) for the Leveraged Freedom Chair	January 2011
2010 Tufts University Young Alumni Distinguished Achievement Award	January 2011
Red Dot Design Award Winner for the Leveraged Freedom Chair	January 2011
ASME/Pi Tau Sigma Gold Medal, awarded to an engineering graduate who has demonstrated outstanding achievement in mechanical engineering within ten years following receipt of the baccalaureate degree	January 2012
Fast Company Magazine Innovation by Design Award, Concept Category, for Leveraged Freedom Chair	January 2012
Mass Challenge Startup Competition, \$100k Diamond Prize Winner, awarded to Global Research Innovation and Technology	January 2012
Rockefeller Foundation \$100k Innovation Challenge Winner	January 2012

Award	Date
Featured talk on TED global website, "Amos Winter: The cheap all-terrain wheelchair," November 20, 2012. http://www.ted.com/talks/amos_winter_the_cheap_all_terrain_wheelchair.html	January 2012
TR35, named one of the 35 innovators under the age of 35 by the MIT Technology Review	October 2013
Freudenstein/General Motors Young Investigator Award (equivalent to best paper), ASME IDETC Mechanisms and Robotics Conference	2014
USPTO Patents for Humanity Award, for the Leveraged Freedom Chair	2015
USAID Desal Prize, First Place	2015
McKinsey Award, for the best article in Harvard Business Review in the past year	2016
Named one of the 2016 Boston Globe Game Changers	2016
Edgerton Award	September 2016
School of Engineering Junior Bose Award for Excellence in Teaching	February 2017
National Science Foundation Faculty Early Career Development (CAREER) Award	September 2017
Best Oral and Written Paper, State-of-the-Art Category, International Desalination Association, World Congress on Water Reuse and Desalination	October 2017
Named to the National Academies "New Voices in Sciences, Engineering, and Medicine (SEM)" initiative, a group of 18 early career SEM leaders	2018
Boston Patent Law Association (BPLA) Honoree at the 10th Annual 'Invented Here!' Awards Event; for "Design of Mechanism for a Low-Cost, Completely Passive Prosthetic Knee for Users with Above-Knee Amputation", US Patent No. 10405997PL	November 2020
J-WAFS Seed Funding Grant	May 2021
Compliant Mechanisms Award (equivalent to best paper award), for paper "Multi-keel Passive Prosthetic Foot Design Optimization Using The Lower Leg Trajectory Error Framework", 2021 ASME IDETC Mechanisms and Robotics Conference.	August 2021
Second Place at the IDA Innovation Forum; World Congress on Charting Resilient Water Solutions. Sydney, Australia	October 2022

13. Current Organization Memberships:

Organization / Activity Description	Offices Held (if any)	Beginning	Ending
Tau Beta Pi Engineering Honor Society		January 2003	-
American Society of Mechanical Engineers		January 2004	-
Sigma Xi: The Scientific Research Society		January 2004	-
Pi Tau Sigma		November 2012	-
Institute of Electrical and Electronics Engineers		July 2015	-
International Desalination Association		July 2015	-

14. Patents and Patent Applications Pending:

#	Patent Description	File Date	Issue Date
1	Winter V, A.G., A.E. Hosoi, A.H. Slocum. "Method and Apparatus for Penetrating Particulate Substrates." US Patent No. 8496410 B2.	June 2009	July 2013
2	Amos G. Winter V, Mario A. Bollini, Danielle M. DeLatte, Harrison F. O'Hanley, Natasha K. Scolnik, Gwyndaf M. Jones, Daniel D. Frey, Benjamin Judge, Benjamin H. Gallup, Danielle Hicks, Nydia Ruleman, Xuefeng Che, "Wheelchair with lever drivetrain", US Patent No. 8844959B2	June 2011	September 2014
3	Amos G Winter, "Turbocharged Single Cylinder Internal Combustion Engine Using an Air Capacitor", US Patent No. 9222405.	July 2014	December 2015
4	Benjamin Michael Judge and Amos Greene Winter V , "Demountable coupling system and apparatus", US Patent No. 9644730B2	September 2015	May 2017
5	Abhijit Joshi, Ruo-Qian Wang, Amos G Winter, Pawel Jerzy Zimoch, "LOW-PRESSURE AND LOW-ENERGY SELF-REGULATING VALVE", US Patent No. 10254770	December 2016	April 2019
6	Venkata Narayana Murthy Arelekatti, Daniel Scott Dorsch, Amos G Winter, "PASSIVE ARTIFICIAL KNEE", US Patent No. 10405997	October 2017	September 2019
7	Pulkit Shamschery, Amos G Winter, "PRESSURE COMPENSATING EMITTER HAVING VERY LOW ACTIVATION PRESSURE AND LARGE OPERATING RANGE", US Patent No. 10426104	August 2016	October 2019
8	Sahil Rajesh Shah, Amos G Winter, Natasha Catherine Wright, "ELECTRODIALYSIS SYSTEMS AND METHODS FOR DESALINATION", US Patent No. 10570032	May 2018	February 2020
9	Abhijit Joshi, Ruo-Qian Wang, Amos G Winter, Pawel Jerzy Zimoch, "LOW-PRESSURE AND LOW-ENERGY SELF-REGULATING VALVE", US Patent No. 10761545	April 2019	September 2020
10	Amos G Winter, Natasha Catherine Wright, "SPIRAL WOUND ELECTRODIALYSIS MODULE", US Patent No. 10926224	October 2018	February 2021
11	Kathryn Michelle Olesnavage, Victor Prost, Amos G Winter, "SPRING DESIGN FOR PROSTHETIC APPLICATIONS", US Patent No. 11324611	August 2019	May 2022
12	Victor Prost, Amos G Winter, "SHAPE OPTIMIZATION FOR PROSTHETIC FEET", US Patent No. 11607325	April 2020	March 2023
13	Lea A Daigle, Guillermo Fabian Diaz Lankenau, Samuel H Ihns, Eric W Koch, Jana I Saadi, Patrick J Tornes, Amos G Winter, Jessica Madison Wu, "ROLL STABILIZATION APPARATUS FOR TWO-WHEELED VEHICLES", US Patent No. 11884348	November 2021	January 2024
14	Guillermo Fabian Diaz Lankenau, Amos G Winter, "VEHICLES FOR CULTIVATION AND TRANSPORTATION", US Patent No. 11895936	October 2021	February 2024
15	Jeffrey Dennis Costello, Dheekshita Kumar, Tristan J McLaurin, Jaya Narain, Julia Alexandrovna Sokol, Amos G Winter, "CHANNEL-LESS DRIP IRRIGATION EMITTERS AND METHODS OF USING THE SAME", US Patent No. 11937556	August 2021	March 2024
16	Hari K. Harikumar, G.G.K. Murthy, Amos G. Winter V, Jena Chittaranjan, "Thin Cambered Airfoil Profiled Blades for Ceiling Fans", Submitted for Indian Patent.	July 2016	-
17	Cavuto, M. L., A. G. Winter V, et al. , "Apparatus and Method for Inserting Electrode Probes into Biological Tissue", GB	October 2018	-

#	Patent Description	File Date	Issue Date
18	Jeffrey Dennis Costello, Dheekshita Kumar, Tristan J McLaurin, Jaya Narain, Julia Alexandrovna Sokol, Amos G Winter, "SYSTEMS AND METHODS FOR DESIGNING AND MODELING PRESSURE-COMPENSATING DRIP EMITTERS, AND IMPROVED DEVICES IN VIEW OF THE SAME", US Patent No.	August 2021	-
19	Kameron Michael Conforti, Grace B Connors, Jeffrey Dennis Costello, Simone Gelmini, Wei He, Anne-Claire Elisabeth Marie Le Henaff, Ian Marius Peters, Amos G Winter, "TIME-VARIANT, MULTI-STAGE CONTROL SYSTEM", US Patent No.	April 2022	-
20	Soraya Honarparvar, Sahil Rajesh Shah, Hannah Martin Varner, Amos G Winter, "SIMPLIFIED ARCHITECTURE FOR DESALINATION VIA ELECTRODIALYSIS", US Patent No.	February 2023	-
21	Kathryn Michelle Olesnavage, Amos G Winter, "METHOD FOR DESIGN AND MANUFACTURE OF COMPLIANT PROSTHETIC FOOT", US Patent No.	April 2023	-
22	Grace B Connors, John H Lienhard, Sahil Rajesh Shah, Quantum J Wei, Amos G Winter, "SYSTEMS AND METHODS FOR COMPACT, DECENTRALIZED DESALINATION OF FEEDWATER FOR POINT-OF-USE APPLICATIONS", US Patent No.	April 2023	-

15. Professional Registration:

None

16. Major New Products, Processes, Designs or Systems:

1. GRIT Freedom Chair – an all-terrain wheelchair designed for the US/European market. The Freedom Chair is manufactured and distributed by GRIT, the company I co-founded.
2. Leveraged Freedom Chair (LFC) – an all-terrain wheelchair designed for developing countries. The LFC was contract manufactured by Pinnacle Industries in Pithampur, India and distributed by GRIT.

Educational Contributions Other Than Classroom Teaching of Amos G. Winter, V

1. Teaching materials developed that illustrate teaching effectiveness or innovativeness (e.g., course syllabi, lecture or recitation content, course handouts, student assignments, educational technology modules):

i. Syllabi available in the educational contributions links below.

2. Education contributions, apart from classroom performance and supervision, such as new educational programs and curricula developed by the candidate (reference pertinent education publications or presentations in other sections of the FPR):

i. **Lecturer and Lab Instructor, SP.784 "Wheelchair Design in Developing Countries"** (Feb.-May 2007-2010)

Massachusetts Institute of Technology

- Developed and implemented a full course curriculum to teach about the issues facing people with disabilities in developing countries.

- Website available at <http://web.mit.edu/sp.784/www/>

ii. **Master Teacher, Introduction to Engineering Class** (June-Aug. 2006-2007)

St. Paul's School Advanced Studies Program

- Developed full course curriculum including a term-long underwater robot project, daily lectures, field trips, demonstrations, lab experiments, and homework problems to teach engineering fundamentals to high school students.

- Website available at: <http://web.mit.edu/awinter/www/ASPIE/index.html>

iii. **Engineering for Global Development Teaching Workshop: Educating Engineers to Address Global Challenges** (Aug. 17, 2014)

ASME IDETC/CIE Conference

- I co-taught this half-day conference with Nathan Johnson from Arizona State University. My half of the curriculum focused on teaching a graduate-level design class on development that incorporated rigorous engineering and development principles.

iv. **Co-Lead Instructor, 2.007 "Design and Manufacturing I" (February 2014 - Present)**

Massachusetts Institute of Technology

- External website: <http://me-2007.mit.edu/>

- <https://stellar.mit.edu/S/course/2/sp20/2.007/index.html>

- Revised course curriculum to enhance students' understanding of engineering design fundamentals and connection of lecture content to the robot competition. This included adding four additional lectures on machine design principles.

- Introduced "Physical Homeworks", where students physically implement concepts from lecture and demonstrate them through quick fabrication projects. These homeworks also teach accountability - 50% of the homework grade is judged on whether their design works.

- Revised how CAD is taught to improve individual learning, open up more lectures to teaching engineering fundamentals, and provide more one-on-one help.

- Updated written homework to provide a closer connection between lecture content and the robot competition.

- Introduced "Gearhead Moments of Zen" into each of my lectures, where we explore the physics behind engineering marvels. These examples teach students how to approach real-life problems rather than following a recipe.

- Introduced "Profiles in Design and Innovation" into each of my lectures, where we discuss a historically important engineer who made contributions to the lecture topic. A diverse set of innovators, many from underrepresented minorities in engineering, are profiled.

- Video recorded every lecture and made them publicly available (with the exception of those containing proprietary material).

- Started the "Engineering Petting Zoo", where corporate sponsors of the class display their cool engineering hardware next to the 2.007 competition. The zoo gives sponsors access to the students for possible employment, and shows the students what type of engineering work they could do in the future (Run 2015-2019).

- Incorporated the de Florez Design Competition into the Engineering Petting Zoo at the 2.007 final competition celebration (Run 2015-2018).

- Navigated the transition to a fully virtual class during the COVID-19 pandemic during spring 2020. Students

continued to develop their robot designs in CAD and through detailed analysis. Their overall experience was still quite positive given the circumstances and the consensus was that they grew as design engineers.

- Spearheaded the effort to create a fully virtual-compatible version of 2.007 during the fall of 2020, in preparation for spring 2021. After seeing the downsides to a fully virtual CAD-based class during spring 2020, the objective of this curriculum was to maintain three primary objectives: 1) enable students to grow their confidence and competence as design engineers through building a robot of their own conception with their own two hands; 2) physically convey important mechanical engineering principles through hands-on interactions, such as friction, over-constraint, tolerance stack-up, compliance, etc.; and 3) foster a feeling of community and camaraderie through a final, live, head-to-head robot competition. In the summer of 2020, I worked with one UROP, and in the fall of 2020 I worked with five UROPs and one TA, to design and refine our new curriculum. Our efforts were focused on creating a kit of tools and materials that would enable a student to make a representative 2.007 robot from their dorm room. We also developed a game board that could be shipped with the kit, enabling students to practice and broadcast their competition rounds from their home. We put together a promotional video (<https://youtu.be/2rjRlqlcST4>) with John Friedah, MIT's videographer, to get students excited, alleviate the fear that virtual 2.007 would be a letdown, and mitigate students delaying taking the class until next year. This video worked, as we had 131 students pre-enroll. Through the summer and fall, we iterated and refined three versions of the kit and ran two mock 2.007 competitions. Going into IAP 2021 we were in a good position to launch the class with high confidence of success in our kit, competition, and new curriculum.
- Spring 2021: Executed a fully virtual-compatible version of 2.007, where each student designed and constructed robots in their own home. This new model of the class offered students the full 2.007 experience while maintaining COVID safety and equity for students who did not have access to campus. Each student received 130 lbs of tools and materials, as well as a competition game board on which to run their robot. We ran a live, fully virtual, head-to-head competition where students competed against their classmates while broadcasting their competition rounds from their own home. To our knowledge, nothing like this had ever been accomplished.
- In my view, 2.007 in 2021 was a triumph and was the most successful version of the class we have ever run in terms of students demonstrating learning objectives! We credit this to the ability to design, iterate, and practice with the robot at home, as well as the "Bill's Build Demo" video series that showed students how to successfully design and fabricate common mechanical subsystems used in the robots. The journey of making this virtual version of 2.007 was documented in video by the department (<https://youtu.be/4ZfyWPNd9N4>) and has received over 135k views.
- Spring 2022: Co-led the best on-campus version of 2.007 we have ever taught! We incorporated many learnings from the pandemic to improve the class. These included mini at-home kits, reducing the size of the robots, reducing the distance and reach required to score points in the competition, utilizing online grading and feedback, and leveraging supplemental video learning modules.
- In the summer of 2022, I was the PI for a project, run by Josh Ramos and Bill Cormier, to make an expanded series of "Bill's Build Demos" videos. These videos show students how to design and fabricate common mechanical modules used in their 2.007 robots. The videos have complementary example hardware that they can explore in the Pappalardo lab.

v. Lead Instructor, 2.76 "Global Engineering" (Sept 2013.-Present)

Massachusetts Institute of Technology

- Internal website: <https://stellar.mit.edu/S/course/2/fa18/2.76/>

- Created and implemented a graduate-level machine and product design class that teaches engineers how to apply their skills within the context of developing and emerging markets. The class mixes rigorous engineering theory with the unique socioeconomic factors of poor countries.

- Technical theory is complemented by readings and guest talks about factors that affect engineering decisions, such as development economics and business strategy. Guest speakers have included Ratan Tata, George Whitesides, Vijay Govindarajan, Bob Hauck (chief mechanical engineer of GE Healthcare) and Rebecca Richards-Kortum.

- Student teams collaborate with global companies to help them create new products and technologies. Example partners include Tata, Mahindra, Okuma, Usha, and Ferrari. A unique element of the class's structure is that students tackle the keystone of a technical challenge posed by the partners, rather than developing a product from scratch. This model enables the students to make a substantive contribution to the partners within the time constraints of a single semester.

- Thus far, the class has produced 11 conference papers, four active patent applications, three new projects in my research group, and one startup company.

- Videotaped every lecture and made them publically available (with the exception of those containing proprietary

material).

- Restarted my 2.76 Global Engineering class after three years of not teaching it. I completely reformatted the curriculum to coincide with the layout of my *Global by Design* book. This worked very well and improved the flow of the class. The students also responded very well to my book and felt it offered a good roadmap through the course.

3. Contributions to the Educational Commons:

- i. 1. From 2014-2018 I ran the "Engineering Petting Zoo" as part of the MIT 2.007 robot competition. Sponsors of the class brought hardware related to their company to showcase, such as a Formula 1 car sponsored by Shell, and students displayed their personal or research hardware projects. The event was aimed at celebrating the design and innovation of physical hardware – a theme well complemented by the 2.007 competition.
2. I started a special seminar series in 2015 called the "Inspiring Engineering Seminar". This seminar has hosted numerous top-level automotive leaders who come to MIT to share their professional work and accomplishments. Past speakers have included John Hennessey (who made the fastest production car), Franco Cimatti (head of road car R&D at Ferrari), and Alex Hitzinger (Technical Director of Porsche's Le Mans winning LMP1 team).
3. I ran the annual de Florez design competition in MechE from 2015-2022. This is our department's main design and innovation competition that rewards ingenuity in engineering and science.
4. I have been the faculty supervisor for the MIT FSAE race car team from 2015-present.
5. I have served on the MIT Behavioral Assessment and Response Team (BART) since 2018. This is a team made up of faculty, staff, and police who discuss potentially dangerous or damaging incidents at MIT and advise the MIT administration and police on how to address them.
6. I have been the faculty supervisor for the MIT Solar Car team from 2020-present.
7. I have served on the MIT Sexual Misconduct Prevention and Response Committee since 2020. The purpose of the committee is to provide guidance to the Provost, the Chancellor, the Vice President for Human Resources, and the Institute Community and Equity Officer as needed; to encourage a campus environment that is safe, respectful and free from discrimination; and to oversee an institute-wide approach to prevent and respond to sexual misconduct and other forms of gender- based discrimination.
8. In fall 2022 I organized a lawn event to celebrate motorsports at MIT. Vermont Sportscar and Redbull displayed one of their record-breaking hill climb cars, MIT's FSAE team displayed their car, and I displayed a race car I built. Approximately 200 students attended.

1. Books

	Publication Name	Publication Date
1.1	Winter, V, A.G., Govindarajan, V. Global by Design, Harvard Business Review Press. (Under contract, manuscript fully drafted, expected to be published in 2024)	2024

2. Papers in Refereed Journals

	Publication Name	Publication Date
2.1	Winter V, A.G. "Assessment of Wheelchair Technology in Tanzania." International Journal for Service Learning in Engineering Vol. 2 No. 1 (Sept. 2006): 66-77.	September 2006
2.2	Winter V, A.G., Smith, A.B. "Assessing MAARDEC: A Comparison with Other Assistive Device Workshop and Disability Organization Models (Innovations Case Discussion: MAARDEC)." Innovations Vol. 3 No. 3 (Summer 2008): 79-81.	January 2008
2.3	Winter V, A.G., Hosoi, A.E. "Identification and Evaluation of the Atlantic Razor Clam (<i>Ensis directus</i>) for Biologically-inspired Subsea Burrowing Systems," Integr. Comp. Biol. 51 (1): 151-157 (2011).	January 2011
2.4	Jung, S., Winter V, A.G., Hosoi, A.E. "Dynamics of Digging in Wet Soil," International Journal of Nonlinear Mechanics. 46, 602 (2011).	January 2011
2.5	Winter V, A.G. "Designing for the Rest of the Global Market" Mechanical Engineering [00256501] 133.09 (2011): 30-37.	September 2011
2.6	Winter V, A.G., Deits, R.L.H., Hosoi, A.E. "Localized Fluidization Burrowing Mechanics of <i>Ensis Directus</i> ," Journal of Experimental Biology, 215 (12): 2072-2080 (2012).	January 2012
2.7	Winter V, A.G. "Helping the Disabled Get Off-Road and On with Their Lives," DEMAND: ASME Global Development Review. 1 (Fall): 18-23 (2013).	October 2013
2.8	Winter V, A.G., Deits, R.L.H., Dorsch, D.S., Slocum, A.H., Hosoi, A.E. "Razor Clam to RoboClam: Burrowing Drag Reduction Mechanisms and their Robotic Adaptation," Bioinspiration & Biomimetics, 9: 1-11.	April 2014
2.9	Wright, N.C., Winter V, A.G. "Justification for Community-Scale Photovoltaic-Powered Electrodialysis Desalination Systems for Inland Rural Villages in India". Desalination, Volume 352, 3 November 2014, Pages 82-91, ISSN 0011-9164	November 2014
2.10	Judge, B.M., Hölttä-Otto, K, Winter V, A.G. "Developing World Users as Lead Users: A Case Study in Engineering Reverse Innovation." ASME Journal of Mechanical Design 2015; 137(7):071406-071406-9.	July 2015
2.11	Winter V, A.G., Govindarajan, V. "Engineering Reverse Innovations." Harvard Business Review. July - August 2015 Issue, pp.80–89.	August 2015
2.12	Nordstrom, K.N., Dorsch, D.S., Losert, W., Winter V, A.G. "A Microstructural View of Burrowing with a BioInspired Digging Robot". Physical Review E. Vol. 92, Issue 4.	October 2015
2.13	Winter V, A.G., Govindarajan, V. "What Engineering a Reverse Innovation Looks Like." Harvard Business Review (online). November 4, 2015.	November 2015
2.14	Mattson, C.A., Winter V, A.G. "Why the Developing World Needs Mechanical Design" ASME Journal of Mechanical Design 2016; 138(7): 070301-070301-3	April 2016
2.15	Isava, M., Winter V, A.G. "Razor Clam-Inspired Burrowing in Dry Soil," International Journal of Non-Linear Mechanics, Volume 81, May 2016, Pages 30-39, ISSN 0020-7462	May 2016

	Publication Name	Publication Date
2.16	Narang, Y.S., Arelekatti, V.N.M., Winter V, A.G. "The Effects of Prosthesis Inertial Properties on Prosthetic Knee Moment and Hip Energetics Required to Achieve Able-bodied Kinematics." IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 24, no. 7, pp. 754-763.	July 2016
2.17	Narang Y.S., Arelekatti V.N.M., Winter V, A.G. "The Effects of the Inertial Properties of Above-Knee Prostheses on Optimal Stiffness, Damping, and Engagement Parameters of Passive Prosthetic Knees." ASME Journal of Biomechanical Engineering. 2016; 138(12):121002-121002-10.	December 2016
2.18	Isava M., Winter V, A.G. "An Experimental Investigation of Digging Via Localized Fluidization, Tested With RoboClam: A Robot Inspired by Atlantic Razor Clams". ASME Journal of Mechanical Design. 2016; 138(12):125001-125001-6.	December 2016
2.19	Nayar K.G., Sundararaman, P., O'Connor, C.L., Schacherl, J.D., Heath, M.L., Gabriel, M.O., Shah, S.R., Wright, N.C., Winter V, A.G. "Feasibility Study of An Electrodialysis System for In-Home Water Desalination in Urban India." Development Engineering, Volume 2, 2017, Pages 38-46, ISSN 2352-7285.	January 2017
2.20	Wang R., Lin T., Shamschery P., Winter V, A.G. "Control of Flow Limitation in Flexible Tubes." ASME Journal of Mechanical Design. 2016; 139(1):013401-013401-8.	January 2017
2.21	Shamschery, P., Wang, R.Q., Tran, D.V., Winter V, A.G. "Modeling the Future of Irrigation: A Parametric Description of Pressure Compensating Drip Irrigation Emitter Performance." PLOS ONE 12(4): e0175241.	April 2017
2.22	Hanumara, N.C., Narain, J., Winter V, A.G. "Digital Magnifying Glasses for Low-Vision Learners: Bringing Assistive Technologies to the Developing World" IEEE Pulse [21542287] 8.5 (2017): 31-35.	September 2017
2.23	Shamschery, P., Winter V, A.G. "Shape and Form Optimization of On-Line Pressure-Compensating Drip Emitters to Achieve Lower Activation Pressure." ASME Journal of Mechanical Design. 2017; 140(3):035001-035001-7.	December 2017
2.24	Watson, S., Bian, D., Sahraei, N., Winter V, A.G., Buonassisi, T., Peters, I.M. "Advantages of Operation Flexibility and Load Sizing for PV-Powered System Design." Solar Energy, March 2018, Vol. 162, 132-139.	March 2018
2.25	Arelekatti, V.N.M., Winter V, A.G. "Design and Preliminary Field Validation of a Fully Passive Prosthetic Knee Mechanism for Users with Transfemoral Amputation in India." ASME Journal of Mechanisms and Robotics. 2018; 10(3):031007-031007-8.	April 2018
2.26	Prost, V., Olesnavage, K.M., Johnson, W.B., Major, M.J., Winter V, A.G. "Design and Testing of a Prosthetic Foot with Interchangeable Custom Rotational Springs for Evaluating Lower Leg Trajectory Error, an Optimization Framework for Prosthetic Feet." ASME Journal of Mechanisms and Robotics. 2018; 10(2):021010-021010-8.	April 2018
2.27	Buchman, M., Ramanujan, D., Winter V, A.G. "A Method for Turbocharging Single-Cylinder, Four-Stroke Engines," SAE International Journal of Engines 11(4):423-434, 2018.	July 2018
2.28	Olesnavage, K.M., Prost, V., Johnson, W.B., Winter V, A.G. "Passive Prosthetic Foot Shape and Size Optimization Using Lower Leg Trajectory Error." ASME Journal of Mechanical Design. 2018; 140(10):102302-102302-11.	July 2018
2.29	Olesnavage, K.M., Winter V, A.G. "A Novel Framework for Quantitatively Connecting the Mechanical Design of Passive Prosthetic Feet to Lower Leg Trajectory." IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 26, no. 8, pp. 1544-1555, Aug. 2018.	August 2018

	Publication Name	Publication Date
2.30	Shah, S. R., Wright, N. C., Nepsky, P., Winter V, A.G. "Cost-Optimal Design of a Batch Electrodialysis System for Domestic Desalination of Brackish Groundwater." Desalination, Volume 443, 2018, Pages 198-211. ISSN 0011-9164.	October 2018
2.31	Wright, N. C., Shah, S. R., Amrose, S.E., Winter V, A.G. "A Robust Model of Brackish Water Electrodialysis Desalination with Experimental Comparison at Different Size Scales." Desalination, Volume 443, 2018. Pages 27-43, ISSN 0011-9164.	October 2018
2.32	Bian, D.W., Watson, S.M., Wright, N.C., Shah, S.R., Buonassisi, T., Ramanujan, D., Peters, I.M., Winter V, A.G. "Optimization and Design of a Low-Cost, Village-Scale, Photovoltaic- Powered, Electrodialysis Reversal Desalination System for Rural India." Desalination, Volume 452, 2019. Online 12/2018. Pages 265-278. ISSN 0011-9164.	February 2019
2.33	Díaz Lankenau, G.F., Winter V, A.G. "An Engineering Review of the Farm Tractor's Evolution to a Dominant Design." ASME Journal of Mechanical Design. Online 02/2019; 141(3): 031107.	March 2019
2.34	Shah, S.R., Walter, S.L., Winter V, A.G. "Using Feed-Forward Voltage-Control to Increase the Ion Removal Rate During Batch Electrodialysis Desalination of Brackish Water." Desalination, Volume 457, 2019, Pages 62-74, ISSN 0011-9164.	May 2019
2.35	Wright, N.C., Winter V, A.G. "Design of Spiral-Wound Electrodialysis Modules" Desalination, Volume 458, 2019, Pages 54-65. ISSN 0011-9164.	May 2019
2.36	Sokol, J., Amrose, S., Nangia, V., Talozzi, S., Brownell, E., Montanaro, G., Abu Naser, K., Bany Mustafa, K., Bahri, A., Bouazzama, B., Bouizgaren, A., Mazahrih, N., Moussadek, R., Sikaoui, L., Winter V, A.G. "Energy Reduction and Uniformity of Low-Pressure Online Drip Irrigation Emitters in Field Tests." Water 2019, 11, 1195.	June 2019
2.37	Narain, J., Winter V, A.G. "A Hybrid Computational and Analytical Model of Inline Drip Emitters." ASME Journal of Mechanical Design. Online March 2019; 141(7): 071405.	July 2019
2.38	He, W., Amrose, S., Wright, N.C., Buonassisi, T., Peters, I.M., Winter, V, A.G. "Field Demonstration of a Cost-Optimized Solar Powered Electrodialysis Reversal Desalination System in Rural India." Desalination, Volume 476, 2020. Online 11/2019. 114217, ISSN 0011-9164.	February 2020
2.39	Diaz Lankenau, G.F., Winter V, A.G. "Design of a Specialized Tractor to Replace Draft Animals in Small Farms." ASME. J. Mech. Des. doi: https://doi.org/10.1115/1.4046811	April 2020
2.40	Diaz Lankenau, G.F., Winter V, A.G. "Investigation of Viability to Replace Draft Animals with All-Wheel-Drive Motorcycles on Small Farms" ASME Journal of Mechanical Design [10500472] 143.1 (2021).	January 2021
2.41	Kent, J., Arelekatti, V.N.M., Petelina, N., Johnson, W.B., Brinkmann, J.T., Winter V, A.G., Major, M.J. "Knee Swing Phase Flexion Resistance Affects Several Key Features of Leg Swing Important to Safe Transfemoral Prosthetic Gait" IEEE Transactions on Neural Systems and Rehabilitation Engineering [15344320] 29. (2021): 965-973.	January 2021
2.42	Olesnavage, K.M., Prost, V., Johnson, W.B., Major, M. J., Winter V, A.G. "Experimental Demonstration of the Lower Leg Trajectory Error Framework Using Physiological Data as Inputs." ASME. J Biomech Eng. March 2021; 143(3): 031003.	March 2021
2.43	He, W., Le Henaff, A., Amrose, S., Buonassisi, T., Peters, I.M., Winter V, A.G. "Voltage and Flow Controlled Electrodialysis Batch Operation: Flexible and Optimized Brackish Water Desalination" Desalination [00119164] 500. (2021): 114837.	March 2021
2.44	Arelekatti, V.N.M., Petelina, N.T., Johnson, W.B., Major, M.J., Winter V, A.G. "Design of a Four-Bar Latch Mechanism and a Shear-Based Rotary Viscous Damper for Single-Axis Prosthetic Knees." ASME. J. Mechanisms Robotics. June 2022; 14(3): 031011. (online November 18, 2021).	November 2021

	Publication Name	Publication Date
2.45	Sokol, J., Narain, J., Costello, J., McLaurin, T., Kumar, D., Winter V, A.G. "Analytical Model for Predicting Activation Pressure and Flow Rate of Pressure-Compensating Inline Drip Emitters and Its Use in Low-Pressure Emitter Design." Irrigation Science; 40, 217–237 (2022).	March 2022
2.46	Prost, V., Johnson, W.B., Kent, J., Major, M., Winter V, A.G. "Biomechanical Evaluation Over Level Ground Walking of User-Specific Prosthetic Feet Designed Using the Lower Leg Trajectory Error Framework." Nature; Scientific Reports 12, 5306 (March 29, 2022).	March 2022
2.47	Grant, F., Sheline, C., Sokol, J., Amrose, S., Brownell, E., Nangia, V., Winter V, A.G. "Creating a Solar-Powered Drip Irrigation Optimal Performance Model (SDrOP) to Lower the Cost of Drip Irrigation Systems for Smallholder Farmers". Applied Energy, Volume 323, 2022, 119563, ISSN 0306-2619.	October 2022
2.48	Johnson, W. B., Prost, V., Mukul, P., Winter V, A.G. "Design and Evaluation of a High-Performance, Low-Cost Prosthetic Foot for Developing Countries." ASME Journal of Medical Devices. Online November 2022.	November 2022
2.49	Prost, V., Peterson, H., Winter V, A.G. "Multi-keel Passive Prosthetic Foot Design Optimization Using the Lower Leg Trajectory Error Framework." ASME Journal of Mechanisms and Robotics. Online November 2022; 15(4): 041001.	November 2022
2.50	S. Honarparvar, R. Al-Rashed, A. G. Winter V. "A Comprehensive Investigation of Performance of Pulsed Electrodialysis for Desalination of Brackish Water". Desalination [00119164] 547. (2023): 116240. Print.	February 2023
2.51	J. N. Easley, A. G. Winter V, S. Talazi "Feasibility and design of solar-powered electrodialysis reversal desalination systems for agricultural applications in the Middle East and North Africa" Desalination [00119164] . (2023): 116628. Print.	April 2023
2.52	V. Prost, W. B. Johnson, J. A. Kent, M. J. Major, A. G. Winter "Systematic Assessment of Prosthesis Stiffness on User Biomechanics Using the Lower Leg Trajectory Error Framework and Its Implication for the Design and Evaluation of Ankle-Foot Prostheses" Journal of Biomechanical Engineering [01480731] 145.4 (2023).	April 2023
2.53	S. Honarparvar, R. Al-Rashed, A. G. Winter V. "Investigation of pulsed electric field operation as a chemical-free anti-scaling approach for electrodialysis desalination of brackish water" Desalination [00119164] 551. (2023): 116386. Print.	April 2023
2.54	Z. Liang, A. L. Shorter, A. G. Winter V. "Quantifying the energetic cost tradeoffs of photovoltaic pumping systems for Sub-Saharan African smallholder farms." Irrigation Science (2023): 1-13.	June 2023
2.55	Burleson, G., Lajoie, J., Mabey, C., Sours, P., Ventrella, J., Peiffer, E., Stine, E., Stettler Kleine, M., MacDonald, L., Austin-Breneman, J., Javernick-Will, A., Winter V, A.G., Lucena, J., Knight, D., Daniel, S., Thomas, E., Mattson, C., Aranda, I. "Advancing Sustainable Development: Emerging Factors and Futures for the Engineering Field." Sustainability. Accepted.	-
2.56	S. Shah, A. G. Winter V. "Evaluating the Production and Exergetic Performance of Point-Of-Use Reverse Osmosis Devices For Brackish Water Desalination." Desalination and Water Treatment. Accepted.	-

3. Proceedings of Refereed Conferences

	Publication Name	Publication Date
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	Publication Name	Publication Date
3.1	Szczesny, S.E., Winter V, A.G. "Design of a Gimbaled Compliant Mechanism Stage for Precision Motion and Dynamic Control in Z, θX & θY Directions." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2: 28th Biennial Mechanisms and Robotics Conference, Parts A and B ():1535-1540. Paper #DETC2004-57589.	August 2004
3.2	Winter V, A.G., et al. "The Leveraged Freedom Chair: A Wheelchair Designed for Developing Countries." 2009 RehabMove Conference. (extended abstract and poster presentation).	April 2009
3.3	Winter V, A.G., et al. "The Leveraged Freedom Chair: A Wheelchair Designed for Developing Countries." Student Design Competition, 2009 RESNA Conference. (extended abstract and poster presentation).	June 2009
3.4	Winter V, A.G., Bollini M.A., DeLatte D.H., O'Hanley H.F., Scolnik N.K. "The Design and Testing of a Low-Cost, Globally-Manufacturable, Multi-Speed Mobility Aid Designed for Use on Varied Terrain in Developing and Developed Countries." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 8: 14th Design for Manufacturing and the Life Cycle Conference; 6th Symposium on International Design and Design Education; 21st International Conference on Design Theory and Methodology, Parts A and B ():657-663. Paper #DETC2009-87609.	August 2009
3.5	Winter V, A.G., Hosoi A.E., Slocum A.H., Deits R.H. "The Design and Testing of RoboClam: A Machine Used to Investigate and Optimize Razor Clam-Inspired Burrowing Mechanisms for Engineering Applications." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 7: 33rd Mechanisms and Robotics Conference (MR), Parts A and B ():721-726. Paper #DETC2009-86808.	August 2009
3.6	Winter V, A.G., et al. "The Design and Fabrication of the East African Trial Leveraged Freedom Chair," 2010 RESNA Conference.	June 2010
3.7	Winter V, A.G., Bellini, M.A., DeLatte, D.H., Judge, B.M., O'Hanley, H.F., Perlman, J.L., Scolnik, N.K. "The Design, Fabrication, and Performance of the East African Trial Leveraged Freedom Chair." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 6: 15th Design for Manufacturing and the Lifecycle Conference; 7th Symposium on International Design and Design Education ():753-760. Paper #DETC2010-29096.	August 2010
3.8	Winter V, A.G., Deits, R.L.H., Dorsch, D.S., Hosoi, A.E., Slocum, A.H. "Multi-Substrate Burrowing Performance and Constitutive Modeling of RoboClam: a Biomimetic Robot based on Razor Clams." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 34th Annual Mechanisms and Robotics Conference (MR). Paper #DETC2010-29060.	August 2010
3.9	Winter V, A.G., Deits, R. L. H., Dorsch, D.S., Hosoi, A.E., Slocum, A.H. "Teaching RoboClam to Dig: The design, testing, and genetic algorithm optimization of a biomimetic robot," 2010 IEEE/RSJ International Conference on Intelligent Robots and Systems, Taipei, 2010, pp. 4231-4235.	October 2010
3.10	Tao, G.D., Cho, H.S., Frey, D., Winter V, A.G. "Design of a Low-Cost Autoclave for Developing World Health Clinics." Design of a Low-Cost Autoclave for Developing World Health Clinics. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 7: 9th International Conference on Design Education; 24th International Conference on Design Theory and Methodology ():297-303. Paper #DETC2012-71435.	August 2012

	Publication Name	Publication Date
3.11	Winter V, A.G, Bollini, M.A., Judge, B.M., Scolnik, N.K., O'Hanley, H.F., Borsch, D.S., Mukherjee, S., Frey, D.D."Stakeholder-Driven Design Evolution of the Leveraged Freedom Chair Developing World Wheelchair." ASME International Mechanical Engineering Congress and Exposition, Volume 5: Education and Globalization; General Topics ():361-368. Paper #IMECE2012-88881.	November 2012
3.12	Winter V, A.G., Stoner, R., Fine, C. "The Tata Center for Technology and Design at MIT." The 2013 International Forum, American Society for Engineering Education Annual Conference.	June 2013
3.13	Winter V, A.G. "Stakeholder and Constraint-Driven Innovation of a Novel, Lever-Propelled, All-Terrain Wheelchair." 25th International Conference on Design Theory and Methodology, ASME IDETC/CIE 2013. Paper #DETC2013-12588.	August 2013
3.14	Zimoch, P.J., Tixier, E., Joshi, A., Hosoi, A.E., Winter V, A.G. "Bio-Inspired, Low-Cost, Self-Regulating Valves for Drip Irrigation in Developing Countries. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5: 25th International Conference on Design Theory and Methodology; ASME 2013 Power Transmission and Gearing Conference ():V005T06A040. Paper #DETC2013-12495.	August 2013
3.15	Banzaert, A., Winter V, A.G. "Design of Agricultural Waste Charcoal Cooking Fuel for Developing Countries." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 4: 18th Design for Manufacturing and the Life Cycle Conference; 2013 ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications ():V004T05A035. Paper #DETC2013-12219.	August 2013
3.16	Winter V, A.G., Deits, R.L.H., Dorsch, D.S. "Critical Timescales for Burrowing in Undersea Substrates via Localized Fluidization, Demonstrated by RoboClam: A Robot Inspired by Atlantic Razor Clams." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 6A: 37th Mechanisms and Robotics Conference ():V06AT07A007. Paper #DETC2013-12798.	August 2013
3.17	Winter V, A.G., Narang, Y., Olesnavage, K. "Balancing Depth and Breadth while Experimentally Validating Medical Technologies for Developing and Emerging Markets." 2014 Tech4Dev International Conference, UNESCO Chair in Technologies for Development: What is Essential? 4-6 June 2014, EPFL, Lausanne, Switzerland.	June 2014
3.18	Narang, Y.S., Winter V, A.G. "Effects of Above-Knee Prosthesis Mass on Optimal Stiffness and Damping Parameters of Prosthetic Knees." 7th World Congress of Biomechanics.	July 2014
3.19	Olesnavage, K.M., Winter V, A.G. "Mimicking Physiological Rollover Shape in a Prosthetic Foot with a Single Degree-of-Freedom Ankle Joint." 7th World Congress of Biomechanics.	July 2014
3.20	Narang, Y.S., Winter V, A.G. "Effects of Above-Knee Prosthesis Mass on Prosthetic Knee Torque and Hip Energetics Required for Normative Kinematics." 7th World Congress of Biomechanics.	July 2014
3.21	Dorsch, D.S., Winter V, A.G. "Design of a Low Energy, Self Contained Subsea Burrowing Robot Based on Localized Fluidization Exhibited by Atlantic Razor Clams." Design of a Low Energy, Self Contained Subsea Burrowing Robot Based on Localized Fluidization Exhibited by Atlantic Razor Clams. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 38th Mechanisms and Robotics Conference ():V05AT08A016. Paper #DETC2014-34953.	August 2014

	Publication Name	Publication Date
3.22	Greenly, A., Murray, T., Lesniewski, V., Jeunnette, M., Winter V, A.G. "Design and Testing of a Low-Cost and Low-Maintenance Drip Irrigation Filtration System for Micro-Irrigation in Developing Countries." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 4: 19th Design for Manufacturing and the Life Cycle Conference; 8th International Conference on Micro- and Nanosystems ():V004T06A050. Paper #DETC2014-35351.	August 2014
3.23	Olesnavage, K.M., Winter V, A.G. "Analysis of Rollover Shape and Energy Storage and Return in Cantilever Beam-Type Prosthetic Feet." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 38th Mechanisms and Robotics Conference ():V05AT08A018. Paper #DETC2014-35174.	August 2014
3.24	Ricks, S.T., Lewandowski, J.R., Lim, E.G., Wendell, D.M., Winter V, A.G. "Development of a Design Tool for Flow Rate Optimization in the Tata Swach Water Filter." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 40th Design Automation Conference ():V02AT03A004. Paper #DETC2014-35320.	August 2014
3.25	Arelekatti, V.N.M., Bjorkdal, D.H., Graves, C.M., Wong, A., Mkrtchyan, A.A., Winter V, A.G. "Proof-of-Concept Evaluation of a Low-Cost and Low-Weight Tractor for Small-Scale Farms. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 40th Design Automation Conference ():V02AT03A034. Paper #DETC2014-35115.	August 2014
3.26	Wright, N.C., Winter V, A.G. "Energetic and Socioeconomic Justification for Solar-Powered Desalination Technology for Rural Indian Villages." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 40th Design Automation Conference ():V02AT03A026. Paper #DETC2014-35176.	August 2014
3.27	Afinogenov, B.I., Coles, J.B., Parthasarathy, S., Press-Williams, J., Tsykunova, R., Vasilenko, A., Narain, J., Hanumara, N.C., Winter V, A.G., Satgunam, P. "Wearable Optical-Digital Assistive Device for Low Vision Students" 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 2083-2086.	August 2014
3.28	Buchman, M., Winter V, A.G. "Method for Turbocharging Single Cylinder Four Stroke Engines." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 16th International Conference on Advanced Vehicle Technologies; 11th International Conference on Design Education; 7th Frontiers in Biomedical Devices ():V003T01A007. Paper #DETC2014-35044.	August 2014
3.29	Wiens, A.J., Winter V, A.G. "A Novel Pressure Compensating Valve for Low-Cost Drip Irrigation." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 38th Mechanisms and Robotics Conference ():V05AT08A042. Paper #DETC2014-35131.	August 2014
3.30	Narang, Y.S., Winter V, A.G. "Effects of Prosthesis Mass on Hip Energetics, Prosthetic Knee Torque, and Prosthetic Knee Stiffness and Damping Parameters Required for Transfemoral Amputees to Walk With Normative Kinematics." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 38th Mechanisms and Robotics Conference ():V05AT08A017. Paper #DETC2014-35065.	August 2014

	Publication Name	Publication Date
3.31	Jacoby, C.L., Jo, Y.S., Jurewicz, J., Pamanes, G., Siegel, J.E., Yen, P.X., Dorsch, D.S., Winter V, A.G. "Design of a Clutchless Hybrid Transmission for a High-Performance Vehicle." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 10: ASME 2015 Power Transmission and Gearing Conference; 23rd Reliability, Stress Analysis, and Failure Prevention Conference ():V010T11A056. Paper #DETC2015-46812.	August 2014
3.32	Hume, D., Isava, M., Koepsell, E., Kriebel, A., Marshall, A., Slocum, J., Jeunnette, M., Winter V, A.G. "Feature Improvement and Cost Reduction of Baitcasting Fishing Reels for Emerging Markets." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5B: 39th Mechanisms and Robotics Conference ():V05BT08A013. Paper #DETC2015-47367.	August 2014
3.33	Arelekatti, V.N., Winter V, A.G. "Design of Mechanism and Preliminary Field Validation of Low-Cost, Passive Prosthetic Knee for Users With Transfemoral Amputation in India." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 39th Mechanisms and Robotics Conference ():V05AT08A043. Paper #DETC2015-47385.	August 2014
3.34	Ricks, S., Winter V, A.G. "Applying Fishbein's Multi-Attribute Attitude Model to the Tata Swach Water Purifier." ICED15 - 20th International Conference on Engineering Design.	July 2015
3.35	Nayar, K.G., Sundararaman, P., Scharcherl, J.D., O'Connor, C.L., Heath, M.L., Gabriel, M.O., Wright, N.C., Winter V, A.G. "Feasibility Study of an Electrodialysis System for In-Home Water Desalination and Purification in Urban India." ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 41st Design Automation Conference ():V02AT03A046. Paper #DETC2015-47613.	August 2015
3.36	Ambrogi, N., Dias-Carlson, R., Gantner, K., Gururaj, A., Hanumara, N., Narain, J., Winter V, A.G., Zielske, I., Satgunam, P., Kumar Bagga, D., Gothwal, V. "Low Vision System for Rapid Near- and Far-Field Magnification Switching," 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Milan, 2015, pp. 5012-5015.	August 2015
3.37	Arelekatti, V.N.M., Winter V, A.G. "Design of a Fully Passive Prosthetic Knee Mechanism for Transfemoral Amputees in India," 2015 IEEE International Conference on Rehabilitation Robotics (ICORR), Singapore, 2015, pp. 350-356.	August 2015
3.38	Olesnavage, K.M., Winter V, A.G. "Lower Leg Trajectory Error: A Novel Optimization Parameter for Designing Passive Prosthetic Feet," 2015 IEEE International Conference on Rehabilitation Robotics (ICORR), Singapore, 2015, pp. 271-276.	August 2015
3.39	Isava, M., Winter V, A.G. "A Theoretical Investigation of the Critical Timescales Needed for Digging in Dry Soil Using a Biomimetic Burrowing Robot." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 39th Mechanisms and Robotics Conference ():V05AT08A048. Paper #DETC2015-47852.	August 2015
3.40	Dorsch, D.S., Winter V, A.G. "Design of a Biologically Inspired Underwater Burrowing Robot That Utilizes Localized Fluidization." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 39th Mechanisms and Robotics Conference ():V05AT08A045. Paper #DETC2015-47459.	August 2015
3.41	Taylor, K., Shamshery, P., Wang, R., Winter V, A.G. "A Mathematical Model for Pressure Compensating Emitters. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 41st Design Automation Conference ():V02AT03A021. Paper #DETC2015-47519.	August 2015

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3.42	Olesnavage, K.M., Winter V, A.G. "Olesnavage KM, Winter AG, V. Design and Qualitative Testing of a Prosthetic Foot With Rotational Ankle and Metatarsal Joints to Mimic Physiological Roll-Over Shape. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 39th Mechanisms and Robotics Conference ():V05AT08A035. Paper #DETC2015-46518.	August 2015
3.43	Wright, N.C., Van De Zande, G., Winter V, A.G. "Justification, Design, and Analysis of a Village-Scale Photovoltaic-Powered Electrodialysis Reversal System for Rural India." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 41st Design Automation Conference ():V02AT03A043. Paper #DETC2015-46521.	August 2015
3.44	Wright, N.C., Van de Zande, G., Winter V, A.G. "Design of a Village-Scale PV Powered Electrodialysis Reversal System for Brackish Water Desalination in India." The International Desalination Association World Congress on Desalination and Water Reuse 2015/San Diego, CA. Paper No: IDA15WC-Wright_51715.	September 2015
3.45	D. Wendell, A. Winter "Gearhead Moments of Zen: Using Real-World Examples Of Supercar Design to Teach Introductory Design and Manufacturing" ASEE Conference & Exposition . (2016): . Print.	January 2016
3.46	Buchman, M.R., Winter V, A.G. "Method for Turbocharging Single-Cylinder, Four-Stroke, Internal Combustion Engines." SAE 2016 World Congress & Exhibition, Detroit, MI. April 12-14, 2016.	April 2016
3.47	Wang, R.Q., Shamshery, P. and Winter V, A.G. "A Novel Bio-Inspired Pressure Compensating Emitter for Low-Cost Drip Irrigation Systems" World Environmental and Water Resources Congress. (2016): 30-36.	May 2016
3.48	Shamshery, P., Winter V, A.G. "Designing a Low Activation Pressure Drip Irrigation Emitter With Constraints for Mass Manufacturing." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 4: 21st Design for Manufacturing and the Life Cycle Conference; 10th International Conference on Micro- and Nanosystems ():V004T05A025. Paper #DETC2016-60078.	August 2016
3.49	Cavuto, M., Chun, M., Kelsall, N., Durgin, K., Baranov, K., Arelekatti, V.N.M., Zhou, M., Winter V, A.G. "Design of Mechanism and Preliminary Field Validation of Low-Cost Transfemoral Rotator for Use in the Developing World." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 40th Mechanisms and Robotics Conference ():V05AT07A035. Paper #DETC2016-59913.	August 2016
3.50	Olesnavage, K.M., Winter V, A.G. "Design and Preliminary Testing of a Prototype for Evaluating Lower Leg Trajectory Error as an Optimization Metric for Prosthetic Feet." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 40th Mechanisms and Robotics Conference ():V05AT07A038. Paper #DETC2016-60565.	August 2016
3.51	Buchman, M., Winter V, A.G. "Validating a Method for Turbocharging Single Cylinder Four Stroke Engines." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 18th International Conference on Advanced Vehicle Technologies; 13th International Conference on Design Education; 9th Frontiers in Biomedical Devices ():V003T01A022. Paper #DETC2016-59593.	August 2016
3.52	Shah, S., Prost, V., Eubanks, Z., Reiter, P., Bondarchuk, D., Hua, Y., Dorsch, D., Winter V, A.G. "Feasibility of a Clutchless Dual-Shaft Hybrid Transmission System for Performance Applications." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 18th International Conference on Advanced Vehicle Technologies; 13th International Conference on Design Education; 9th Frontiers in Biomedical Devices ():V003T01A035. Paper #DETC2016-59955.	August 2016

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3.53	Bian, D., Watson, S., Sokol, J., Yun J., Mascarenhas, C., Emeghara, C., Winter V, A.G., Wright, N., Buresh, C., Vander Werff, A. "Development of a Village-Scale, Solar-Powered Reverse Osmosis System. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2A: 42nd Design Automation Conference (V02AT03A051. Paper #DETC2016-59646.	August 2016
3.54	Narain, J., Winter V, A.G. "Determination of Resistance Factor for Tortuos Paths in Drip Emitters." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 2B: 43rd Design Automation Conference (DAC): V02BT03A017. Paper #DETC2017-67895.	August 2017
3.55	Prost, V., Olesnavage, K.M., Winter V, A.G. "Design and Testing of a Prosthetic Foot Prototype with Interchangeable Custom Rotational Springs to Adjust Ankle Stiffness for Evaluating Lower Leg Trajectory Error, an Optimization Metric for Prosthetic Feet." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 5B: 41st Mechanisms and Robotics Conference (MR): V05BT08A015. Paper #DETC2017-67820.	August 2017
3.56	Amiot, D.E., Schmidt, R.M., Law, A., Meinig, E.P., Yu, L., Olesnavage, K.M., Prost, V., Winter V, A.G. "Development of a Passive and Slope Adaptable Prosthetic Foot." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 5A: 41st Mechanisms and Robotics Conference (MR): V05AT08A066. Paper #DETC2017-67947.	August 2017
3.57	Olesnavage, K.M., Winter V, A.G. "Passive Prosthetic Foot Shape and Size Optimization Using Lower Leg Trajectory Error." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 5A: 41st Mechanisms and Robotics Conference (MR): V05AT08A011. Paper #DETC2017-67618.	August 2017
3.58	Arelekatti, V.N.M., Joh, Y., Warner, J.C., Berringer, M.A., Boehmcke, P.J., Fischman, J.Z., Huang, A.Y., Major, M., Winter V, A.G. "Modular Design of a Passive, Low-Cost Prosthetic Knee Mechanism to Enable Able-Bodied Kinematics for Users with Transfemoral Amputation." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 5B: 41st Mechanisms and Robotics Conference (MR): V05BT08A028. Paper #DETC2017-68278.	August 2017
3.59	Bautista, B.N., Diaz Lankenau, G.F., Guitron, S.P., Jennings, B.D., Nechlani, R., Tang, A.S., Tucker, M.R., Winter V, A.G. "Design of an Integrated Cotton-Picking System for Small-Scale Indian Agriculture" ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 4: 22nd Design for Manufacturing and the Life Cycle Conference; 11th International Conference on Micro- and Nanosystems: V004T05A028. Paper #DETC2017-68132.	August 2017
3.60	Wright, N.C., Winter V, A.G. "Village-Scale Electrodialysis Desalination: Field Trial Validation." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Vol. 2B: 43rd Design Automation Conference (DAC): V02BT03A019. Paper #DETC2017-68410.	August 2017
3.61	Buchman, M., Winter V, A.G. "Investigating the Effect of Intake Manifold Size on the Transient Response of Single Cylinder Turbocharged Engines." 13th International Conference on Engines and Vehicles. SAE Technical Paper 2017-24-0170.	September 2017
3.62	Shah, S.R., Wright, N.C., Nepsky, P., Winter V, A.G. "Optimal Design of a Batch Electrodialysis System for Domestic Desalination." International Desalination Association, World Congress on Water Reuse and Desalination, São Paulo. IDA17WC-58064. Oct 15-20, 2017. Awarded Best Oral and Written Paper Presented in the Technical Program in the Category of State-of-the-Art.	October 2017

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3.63	Bian, D., Watson, S.M., Wright, N.C., Shah, S., Peters, I. M., Ramanujan, D., Buonassisi T., Winter V, A.G. "Cost-Optimization of Solar-Powered Electrodialysis Reversal Systems for Desalination in Rural India." International Desalination Association, World Congress on Water Reuse and Desalination, São Paulo. IDAWC REF: 17WC-58067.	October 2017
3.64	Ramanujan, D., Wright, N., Truffaut, S., von Medeazza, G., Winter V, A.G. "Sustainability Analysis of PV-Powered Electrodialysis Desalination for Safe Drinking Water in the Gaza Strip." International Desalination Association, World Congress on Water Reuse and Desalination, São Paulo. IDAWC REF: 17WC-58045.	October 2017
3.65	Wright, N.C., Winter V, A.G. "Model and Experimental Validation of a Spiral-Wound Electrodialysis Module." International Desalination Association, World Congress on Water Reuse and Desalination, São Paulo. IDA17WC-57872.	October 2017
3.66	Winter V, A.G. "Designing and Testing Low-Cost, Single-Part Energy Storage and Return Prosthetic Feet Using the Lower Leg Trajectory Error Framework." Oral Presentation. Dynamic Walking Conference, May 21 - 24, 2018, Pensacola, FL. https://www.youtube.com/watch?v=EKMW91t7Utg&t=2s	May 2018
3.67	Prost, V., Olesnavage, K., Johnson, W.B., Winter V, A.G. "Design and Preliminary Testing of a Passive Prosthetic Foot Optimized for Lower Leg Trajectory Error." 8th World Congress of Biomechanics.	July 2018
3.68	Winter V, A.G. "Designing passive prosthetic legs that naturally mimic able-bodied kinematics and kinetics." 8th World Congress of Biomechanics.	July 2018
3.69	Arelekatti, M., Petelina, N, Johnson, W.B., Major, M., Winter V, A.G. "Mechanical Component Optimization, Design and Testing of a Fully Passive Prosthetic Knee Mechanism." 8th World Congress of Biomechanics.	July 2018
3.70	Dorsch, D.S., Carrus, J., Wallach, M., Xu, Z., Xu, D., Dokras, N., Marquart, T., Winter V, A.G. "Experimental Setup to Characterize Shift Time for High Performance Hybrid Transmissions." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 20th International Conference on Advanced Vehicle Technologies; 15th International Conference on Design Education. V003T01A041. Paper #DETC2018-85617.	August 2018
3.71	Arelekatti, V.N.M., Petelina, N.T., Johnson, W.B., Major, M.J., Winter V, A.G. "Design of a Passive, Shear-Based Rotary Hydraulic Damper for Single-Axis Prosthetic Knees." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 5A: 42nd Mechanisms and Robotics Conference (MR): V05AT07A064. Paper #DETC2018-85962.	August 2018
3.72	Sokol, J., Grant, F., Sheline, C., Winter V, A.G. "Development of a System Model for Low-Cost, Solar-Powered Drip Irrigation Systems in the MENA Region." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2B: 44th Design Automation Conference (DAC): V02BT03A022. Paper #DETC2018-86297.	August 2018
3.73	Phadnis, V., Harris, J., Ding, S., Arambula, C., Collins, B., Jeunnette, M., Winter V, A.G. "Engine Mount Design Strategies to Mitigate Linear Vibrations in a Tata Nano." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 20th International Conference on Advanced Vehicle Technologies; 15th International Conference on Design Education. V003T01A042. Paper #DETC2018-85834.	August 2018

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3.74	Buchman, M., Johnson, W.B., Winter V, A.G. "Analyzing the Effect of Air Capacitor Turbocharging Single Cylinder Engines on Fuel Economy and Emissions Through Modeling and Experimentation." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 3: 20th International Conference on Advanced Vehicle Technologies; 15th International Conference on Design Education. V003T01A043. Paper #DETC2018-85934.	August 2018
3.75	Diaz Lankenau, G.F., Winter V, A.G. "An Engineering Review of the Farm Tractor's Evolution to a Dominant Design." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2B: 44th Design Automation Conference (DAC): V02BT03A021. Paper #DETC2018-86285.	August 2018
3.76	Narain, J., Winter V, A.G. "A Hybrid Computational and Analytical Model of Inline Drip Emitters." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2B: 44th Design Automation Conference (DAC): V02BT03A018. Paper #DETC2018-85871.	August 2018
3.77	He W., Wright N.C., Amrose S., Buonassi T., Peters I.M., Winter V A.G. "Preliminary Field Test Results from a Photovoltaic Electrodialysis Brackish Water Desalination System in Rural India." ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Volume 2B: 44th Design Automation Conference (DAC): V02BT03A020. Paper #DETC2018-86183.	August 2018
3.78	Arelekatti, V.N.M., Petelina, N., Johnson, W.B., Winter V, A.G., Major, M.J. "Design of a Passive, Shear-Based Rotary Hydraulic Damper for Single-Axis Prosthetic Knees" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V05AT07A064.	August 2018
3.79	Dorsch, D.S., Carrus, J., Xu, Z., Xu, D., Winter V, A.G., Wallach, M., Dokras, N., Marquart, T. "Experimental Setup to Characterize Shift Time for High Performance Hybrid Transmissions" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V003T01A041.	August 2018
3.80	Sokol, J., Grant, F., Sheline, C., Winter V, A.G. "Development of a System Model for Low-Cost, Solar-Powered Drip Irrigation Systems in the MENA Region" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V02BT03A022.	August 2018
3.81	He, W., Wright, N.C., Amrose, S., Buonassisi, T., Peters, I.M., Winter V, A.G. "Preliminary Field Test Results From a Photovoltaic Electrodialysis Brackish Water Desalination System in Rural India" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V02BT03A020.	August 2018
3.82	Phadnis, V.S., Harris, J., Ding, S., Arambula, C., Collins, B., Jeunnette, M., Winter V, A.G. "Engine Mount Design Strategies to Mitigate Linear Vibrations in a Tata Nano" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V003T01A042.	August 2018
3.83	Narain, J., Winter V, A.G. "A Hybrid Computational and Analytical Model of Inline Drip Emitters" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V02BT03A018.	August 2018
3.84	Díaz Lankenau, G.F., Winter V, A.G. "An Engineering Review of the Farm Tractor's Evolution to a Dominant Design" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V02BT03A021.	August 2018

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3.85	Buchman, M.R., Johnson, W.B., Winter V, A.G. "Analyzing the Effect of Air Capacitor Turbocharging Single Cylinder Engines on Fuel Economy and Emissions Through Modeling and Experimentation" ASME International Design Engineering Conferences and Computers and Information in Engineering Conference . (2018): V003T01A043.	August 2018
3.86	Sokol, J., Narain, J., Winter V, A.G., "Experimental apparatus for rapid prototyping of pressure-compensating inline drip irrigation emitters," 71st Annual Meeting of the American Physical Society's Division of Fluid Dynamics, Atlanta, GA.	November 2018
3.87	Narain, J., Winter V, A.G., "DEM Study of Clogging in Millimeter Scale Channels in Drip Irrigation Emitters," 71st Annual Meeting of the American Physical Society's Division of Fluid Dynamics, Atlanta, GA.	November 2018
3.88	Petelina, N., Arelekatti, V.N.M., Winter V, A.G. "Exploring the Role of Damping in a Passive Prosthetic Knee through Design, Modelling, and Experiments." Poster Presentation at Dynamic Walking Conference 2019. Canmore, Alberta, Canada.	June 2019
3.89	Le Henaff, A-C., He, W., Buonassisi, T., Winter V, A.G., Peters, I.M. "Flexible Operation of Photovoltaic Electrodialysis (PV-ED) Low-Cost Community-Scale Desalination Systems." IEEE PVSC 2019 Proceedings [Volume 2]	June 2019
3.90	Johnson, W.B., Winter V, A.G. "Kinetic Requirements for Reciprocal Gait in Persons with Paraplegia." Dynamic Walking Conference 2019. Canmore, Alberta, Canada. Page 48.	June 2019
3.91	Prost, V., Johnson, W.B., Kent, J.A., Major, M.J., Winter V, A.G. "Design and Testing of Passive Prosthetic Feet Optimized Using the Lower Leg Trajectory Error Metric" Poster Presentation at Dynamic Walking Conference 2019. Canmore, Alberta, Canada.	June 2019
3.92	A. Le Henaff, W. He, T. Buonassisi, A. G. Winter, I. M. Peters "Flexible operation of photovoltaic electrodialysis (PV-ED) low-cost community-scale desalination systems" IEEE Photovoltaic Specialists Conference (PVSC) . (2019): 1-5. Print.	June 2019
3.93	Beirut, S., Le Henaff, A., Chandar, A., Zhang, Z., Gee, K., Narain, J., Jones, A., Winter, A.G. "A Novel, Efficient 3D-Printing Based Manufacturing Process for Custom Ocular Prostheses" International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) . (2019): 3734-3737.	July 2019
3.94	Engelkemier, S., Grant, F., Landis, J., Sheline, C., Varner, H., Zubajlo, R. E., Sokol, J., Winter V, A.G. "Feasibility of Pairing a Low-Cost Positive Displacement Pump With Low-Energy Pressure Compensating Drip Irrigation Emitters for Smallholder Farms in Africa." Proceedings of the ASME 2019 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 2B: 45th Design Automation Conference. Anaheim, California, V02BT03A005.	August 2019
3.95	Diaz Lankenau, G.F., Daigle, L., Ihns, S.H., Koch, E., Saadi, J., Tornes, P., Wu, J.M., and Winter V, A.G. "Design of a Human-Powered Roll Stabilization Attachment for Utilitarian Two-Wheeled Vehicles." Proceedings of the ASME 2019 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 3: 21st International Conference on Advanced Vehicle Technologies; 16th International Conference on Design Education. Anaheim, California. V003T01A035.	August 2019
3.96	Alowayed, A., Fernandes, D., Jeunehomme, E., Liu, S., Wang, Z., Yang, I., Dorsch, D., and Winter V, A.G.. "Design of an Electric Motor Transmission System Without Friction Synchronization." Proceedings of the ASME 2019 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 10: 2019 International Power Transmission and Gearing Conference. Anaheim, California. V010T11A045.	August 2019

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3.97	Johnson, W.B., Winter V, A.G. "Modeling the Biomechanical Requirements of Reciprocal Gait with Orthoses for Persons with Lower Limb Paralysis." 17th World Congress of International Society of Prosthetics and Orthotics. Kobe, Japan. Page 360.	October 2019
3.98	Prost, V., Johnson, W.B., Kent, J.A., Major, M.J., Winter, V A.G. "Design and Testing of Passive Prosthetic Feet Optimized Using the Lower Leg Trajectory Error Metric." 17th World Congress of International Society of Prosthetics and Orthotics. Kobe, Japan. Page 217.	October 2019
3.99	Petelina, N., Arelekatti, V.N.M., Johnson W.B., Major, M.J., Winter, A.G. "Design and Testing of a Low-Cost, Passive Prosthetic Knee with a Rotary Hydraulic Damper." 17th World Congress of International Society of Prosthetics and Orthotics. Kobe, Japan. Page 438.	October 2019
3.100	Le Henaff, A-C., He, W., Costello, J., Winter V, A.G. "Time-Variant Operation of Solar-Powered Electrodialysis Systems." International Desalination Association, World Congress 2019. Dubai, United Arab Emirates.	October 2019
3.101	Shah, S.R., Walter, S.L., Wright, N.C., Winter V, A.G., "Batch Electrodialysis Desalination of Brackish Water using Active Voltage Control." International Desalination Association, World Congress 2019. Dubai, United Arab Emirates.	October 2019
3.102	He, W., Le Henaff, A-C., Costello, J., Winter V, A.G. "Time-Variant Electrodialysis Desalination." International Desalination Association, World Congress 2019. Dubai, United Arab Emirates.	October 2019
3.103	Al-Rashed, R.A., Wright, N.C., Winter V, A. G. "Modeling of Pumping Power in Electrodialysis Stacks Across Size Scales." International Desalination Association, World Congress 2019. Dubai, United Arab Emirates.	October 2019
3.104	Amrose, S., Sokol, J., Grant, F., Sheline, C., Brownell, E., Montanaro, G., Bahri, A., Bouazzama, B., Bouizgaren, A., Moussadek, R., Sikaoui, L., Nangia, V., Winter, A.G., "Multi-Season Field Tests of Low Energy Online Drip Irrigation Emitters." 5th African regional conference of ICID, March 2020.	March 2020
3.105	Prost, V., Johnson, W. B., Kent, J. A., Major, M. J., and Winter, A. G., 2020, "Experimental Investigation of the Lower Leg Trajectory Error Metric: Implication for the Design of Ankle-Foot Prostheses," 15th Annual Dynamic Walking Conference, Pennsylvania, USA.	May 2020
3.106	Van De Zande, G., Amrose, S., Winter V, A.G. "Evaluating the Potential for Low Energy Emitters to Facilitate Solar-Powered Drip Irrigation in Sub-Saharan Africa" Proceedings of the Design Society: DESIGN Conference [26337762] 1. (2020): 2177-2186. Print.	May 2020
3.107	Varner, Hannah M., Shah, Sahil R., and Winter V, Amos G. "The Determination of a Cost Optimal Design for a Multiple Stage Continuous Electrodialysis Desalination Device for Use in Domestic Point of Use Water Purification." Proceedings of the ASME IDETC/CIE. DETC2020-22760. Online, Virtual.	August 2020
3.108	Grant, F., Sheline, C., Amrose, S., Brownell, E., Nangia, V., Talazi, S., & Winter, A. "Validation of an Analytical Model to Lower the Cost of Solar-Powered Drip Irrigation Systems for Smallholder Farmers in the Mena Region. Proceedings of the ASME IDETC/CIE. DETC2020-22610. Online, Virtual.	August 2020
3.109	Sokol, J., Sheline, C., Grant, F., Amrose, S., Winter, A.G. "Techno-Economic Feasibility of Standard- and Low-Pressure Drip Irrigation Systems for Smallholder Farmers." The 8th World Sustainability Forum.	September 2020
3.110	Amrose, S., Connors, G., Sokol, J., Grant, F., Sheline, C., Winter V, A.G. "Integrated, Low-Cost, Renewable-Powered Electrodialysis Desalination and Drip Irrigation For Us Markets." ASABE 6th Decennial Irrigation Meeting. Nov 2020.	November 2020

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3.111	Folinus, C.M., Prost, V., Winter V, A.G. "Experimental Investigation of Passive Prosthetic Feet Designed for Multiple Walking Activities using the Lower Leg Trajectory Error Methodology," 16th Annual Dynamic Walking Conference, Virtual, USA. 2021.	June 2021
3.112	Prost, V., Peterson, H.V., Winter V, A.G. "Multi-Keel Passive Prosthetic Foot Design Optimization Using the Lower Leg Trajectory Error Framework." Proceedings of the ASME 2021 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 8A: 45th Mechanisms and Robotics Conference (MR). Virtual, Online. August 17–19, 2021. V08AT08A039. ASME.	August 2021
3.113	Sheline, C., Winter V, A.G. "Machine Learning Method for Forecasting Weather Needed for Crop Water Demand Estimations in Low-Resource Settings Using A Case Study in Morocco". Proceedings of the ASME 2021 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 3B: 47th Design Automation Conference (DAC). Virtual, Online. August 17–19, 2021. V03BT03A016.	August 2021
3.114	Folinus, C.M., Winter V, A.G. "Design of Customized, 3D Printed Prosthetic Feet using the Lower Leg Trajectory Error Metric". 18th World Congress of the International Society of Prosthetics and Orthotics. Virtual.	November 2021
3.115	Honarparvar, S., Al-Rashed, R., Winter V, A.G. "Effects of Temporal Parameters of Pulsed Electric Field Operation on Desalination Performance and Water Dissociation in Electrodialysis". 2021 AIChE Annual Meeting, Boston, MA.	November 2021
3.116	Ghodgaonkar, A.A., Sokol, J.A., Winter V, A.G. "Development and Validation of a Fully Analytical Model for Designing Pressure-Compensating Flow Devices for Drip Irrigation and Other Applications". 74th Annual Meeting of the APS Division of Fluid Dynamics. 2021.	November 2021
3.117	Folinus, C.M., Winter V, A.G. "Design of Customizable, High Performance, and Rapidly Providable Passive Prosthetic Feet." 17th Annual Dynamic Walking Conference. Madison, Wisconsin. June 13 – 16, 2022.	June 2022
3.118	Folinus, C.M., Winter V, A.G. "Design of Commercially Viable, Personalized Passive Prosthetic Feet." World Congress of Biomechanics. Taipei, Taiwan. July 10 – 14, 2022.	July 2022
3.119	Van de Zande, G.D., Sheline, C, Winter V, A.G. "Evaluating the Potential for a Novel Irrigation System Controller to Be Adopted by Medium-Scale Contract Farmers in East Africa." Proceedings of the ASME 2022 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 6: 34th International Conference on Design Theory and Methodology (DTM). St. Louis, Missouri, USA. August 14–17, 2022. V006T06A037.	August 2022
3.120	Bessette, J.T., Winter V, A.G. "The Need for Desalination in Humanitarian Crises." Proceedings of the ASME 2022 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 3B: 48th Design Automation Conference (DAC). St. Louis, Missouri, USA. August 14–17, 2022. V03BT03A005. ASME.	August 2022
3.121	Bessette, J., Pratt, S.R. and Winter V, A.G. "Robust Control and Experimental Validation of a Direct Drive Photovoltaic Electrodialysis Desalination System." International Desalination Association, World Congress on Charting Resilient Water Solutions. Sydney, Australia. October 9-13, 2022.	October 2022
3.122	Connors, G., Gelmini, S. and Winter V, A.G. "Robust Control and Experimental Validation of a Direct Drive Photovoltaic Electrodialysis Desalination System." International Desalination Association, World Congress on Charting Resilient Water Solutions. Sydney, Australia.	October 2022

	Publication Name	Publication Date
3.123	Bessette, J., Pratt, S., Tran, J., Costello, J., Winter V, A.G. "Semi-Batch Electrodialysis Reversal: A Simplified Architecture and Control Method for Flexible, Low-Cost, Off-Grid Desalination." European Desalination Society. Desalination for the Environment, Clean Water, and Energy. May 22–26, 2023. Cyprus.	May 2023
3.124	Brei, M., Tran, J., Costello, J., Winter V, A.G. "Co-Design of an Off-Grid, Community Desalination System in the Navajo Nation." European Desalination Society. Desalination for the Environment, Clean Water, and Energy. May 22–26, 2023. Cyprus.	May 2023
3.125	Petelina, N., Shorter, A.L., Tutuianu, M., Winter V, A.G. "Experimental Validation of Hip Trajectory Error Feet for Knee Amputees." Dynamic Walking Conference, June 12-16 2023, Munich, Germany.	June 2023
3.126	Irani, U., Winter V, A.G. "Design of a Mass-Manufacturable, Globally Distributable Passive Prosthetic Foot." Dynamic Walking Conference, June 12-16 2023, Munich, Germany.	June 2023
3.127	Shorter, A.L., Petelina, N., Winter V, A.G. "Perception of Typical Walking for Understanding Prosthetic Leg Design User Requirements." Dynamic Walking Conference, June 12-16 2023, Munich, Germany.	June 2023
3.128	Floryan, M., Bowers, Q., Sternberg, Z., Gembali, S., Goyal, A., Bessette, J., Honarparvar, S., Winter V, A.G. "Lab-to-Market Design of an Electrodialysis-Based Home-Scale Water Desalination System." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-112625. ASME. Boston, USA.	August 2023
3.129	Brei, M., Winter V, A.G. "Feasibility of Small-Scale, Off-Grid Desalination in the Navajo Nation." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-113479. ASME. Boston, USA.	August 2023
3.130	Reddie, M., Bedi, S., Vaidya, M., Griffen, A., Petelina, N., Winter V, A.G. "Achieving High Performance and Low Cost: Development of a High-Performing Passive Prosthetic Knee for Emerging Market." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-116478. ASME. Boston, USA.	August 2023
3.131	Van de Zande, G.D., Sheline, C., Amrose, S., Costello, J., Ghodgaonkar, A., Grant, F., Winter V, A.G. "Design and Evaluation of an Automatic Scheduling-Manual Operation tool to Bring Precision Irrigation to Resource-Constrained Farmers." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-12470. ASME. Boston, USA.	August 2023
3.132	Ghodgaonkar, A., Welsh, E., Judge, B., Bono, M., Winter V, A.G. "An Empirical, Deterministic Design Theory for Compact Drip Emitter Labyrinths." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-116552. ASME. Boston, USA.	August 2023
3.133	Crawford, C., Smyk, M., Cheung, S., Coughran, D., Costello, J., Liang, Z., Winter V, A.G. "Proposed Design for Electromechanical Telescoping Actuator to Replace Hydraulics in Extreme High Force and Long Stroke Applications." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-115098. ASME. Boston, USA.	August 2023

	Publication Name	Publication Date
3.134	Sagar, P., Irani, U., Tagoe, J., Khaguli, S., Ghodgaonkar, A., Winter V, A.G. "Design and Validation of a Modular Device to Convert Off-the-Shelf Leaf Blowers to Fish Feed Distribution Systems for Use in Aquaculture Farms in Ghana." Proceedings of the ASME 2023 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. August 20–23, 2023. DETC-114723. ASME. Boston, USA.	August 2023

4. Other Major Publications

	Publication Name	Publication Date
4.1	Winter V, A.G. "Design of Fluid Film Journal Bearings Containing Continuous 3D Fluid Pathways which are formed by Wrapping a Sheet Containing 2D Through-Cut Features." Masters Thesis, MIT Department of Mechanical Engineering, June 2005.	June 2005
4.2	Winter V, A.G., Hotchkiss, R. "Mechanical Principles of Wheelchair Design." 2006.	January 2006
4.3	Winter V, A.G. "A Serendipitous Passion: How a Public Service Center fellowship got me hooked on international development." Technology Review, May/June 2008.	June 2008
4.4	Winter V, A.G. "Biologically Inspired Mechanisms for Burrowing in Undersea Substrates." Ph.D. Thesis, MIT Department of Mechanical Engineering, February 2011.	February 2011
4.5	Winter V, A.G., Childs, J., Tak, J. "Case Study: Leveraged Freedom Chair." Core 77, Feb. 6, 2011.	February 2011
4.6	Winter V, A.G. "Designing for the Rest of the Global Market: Engineering's New Frontier." Mechanical Engineering Vol. 133/No. 9 Sept. 2011.	September 2011
4.7	Winter V, A.G. "Stakeholder-Driven Design." Mechanical Engineering Magazine, Feb. 2013.	February 2013
4.8	Winter V, A.G. "Research for Development." Mechanical Engineering Magazine, May 2013.	May 2013
4.9	Winter V, A.G. "Constraint-Driven Innovation." Mechanical Engineering Magazine, Aug. 2013.	August 2013
4.10	Winter V, A.G. "The Right Trajectory." Mechanical Engineering Magazine, Nov. 2013.	November 2013
4.11	Winter V, A.G. "Why Investing in Research for the Developing World Will Benefit the United States Too." NAE The Bridge, Nov. 2015.	November 2015
4.12	Winter, V. A.G., Govindarajan, V. "Engineering Reverse Innovations". Chapter in HBR's 10 Must Reads 2017. p. 63. 2017.	2017
4.13	Brown, T., Christensen, C.M., Nooyi, I., Govindarajan, V. "HBR's 10 Must Reads: on Design Thinking" Harvard Business Press, April 28, 2020.	April 2020
4.14	"Developing Community Around Design: MIT Morningside Academy for Design's Inaugural Fellows Chart a New Course", on MIT NEWS.	October 2022
4.15	"J-WAFS and MIT community members win IDA Innovation Forum Awards", on MIT J-WAFS News.	October 2022
4.16	"MIT PhD Students Shed Light on Important Water and Food Research", MIT News.	November 2022

	Publication Name	Publication Date
4.17	"MIRRA and MIT are Testing a Promising and Innovative Irrigation Controller in the Jordan Valley", MIRRA's December Newsletter.	December 2022
4.18	Henaff, A-C., He, W., Amrose, S., Buonassisi, T., Peters, I.M., Winter V, A.G. "Flexible Solar-Powered Batch Electrodialysis Reversal Desalination for Affordable Off-Grid Clean Water Supply." (In Review)	-
4.19	Buchman, M., Johnson, W.B., Winter V, A.G. "Methodology for Optimizing Air Capacitor Turbocharged Single Cylinder Engines for Specific Applications." (In Preparation)	-
4.20	Arelekatti, V.N.M, Petelina, N., Johnson, W.B., Kent, J., Major, M.J., Winter V, A.G. "Estimation of Recommended Damping Coefficient Range to Achieve Target Peak Knee Flexion in a Passive Prosthetic Knee." (In Preparation)	-
4.21	Brownell, E., Ramanujan, D., Wright, N.C., von Medeazza, G., Winter V, A.G. "Design and Evaluation of a Community-Scale, PV-Powered Electrodialysis Reversal Brackish Water Desalination System for Producing Safe Drinking Water in the Gaza Strip." (In Review)	-
4.22	Wright, N.C., Shah, S.R., Winter V, A.G., "Comparison of Cost-Optimal Design and Operation Modes for Small-Scale Brackish Water Electrodialysis Desalination." (In Preparation)	-
4.23	Dorsch, D.S., Jacoby, C.J., Siegel, J.E., Shah, S.R., Prost, V., Winter V, A.G. "A Framework and Case Studies for Designing Novel High-Performance Hybrid Transmissions." (In Preparation)	-
4.24	Dorsch, D.S., Gelmini, S., Pratt, S., Winter V, A.G. "Design and Experimental Validation of a Dogtooth Position Tracking System for Gearshifts in an Automated Manual Transmission." (In Preparation)	-
4.25	Varner, H.M., Shah, S.R., Winter V, A.G. "Architecture and Unit Design of A Capital Cost Optimized, Household Electrodialysis Desalination Device with Continuous Flow." (In Preparation)	-
4.26	Donlon, Elliott S., Amrose, Susan E., Meyer, David, Winter V, A.G. "Assessment of High-Value Near-Term Engineering Innovations for Indian Sanitation." (In Preparation)	-
4.27	Al-Rashed, R., Winter V, A.G. "Community-Scale Brackish Water Desalination in India: Comparison of Batch EDR and Continuous RO Systems." (In Preparation)	-
4.28	Ghodgaonkar, Aditya A., Sokol, Julia A., Winter V, A.G. "Designing Low-Cost, Low-Pressure Pressure-Compensating Inline Emitters: Development of and Use-Case for a Holistic Analytical-Experimental Design Framework." (In Preparation)	-
4.29	Shah, S., Winter V, A.G. "Validating a Simple Model for Estimating Recovery and Specific Energy Consumption of Single-Stage Reverse Osmosis Systems." (In Preparation)	-
4.30	Shah, S., Winter V, A.G. "Gear and Sliding Vane Mechanisms as Energy Recovery Devices in Small-Scale Reverse Osmosis Applications: A Technical Feasibility Study." (In Preparation)	-
4.31	Shah, S., Winter V, A.G. "An Experimental ERD for PV-BWRO Using Off-the-Shelf Vane Pumps." (In Preparation)	-
4.32	Van de Zande, G.D., Amrose, S., Shamsberry, P., Donlon, E., Liang, Z., Winter V, A.G. "Identifying Opportunities for Irrigation Systems to Better Suit the Targeted Needs of Farmers in East Africa." (In Review)	-
4.33	Folius, C.M., Winter V, A.G. "Design and Mechanical Validation of Commercially Viable, Personalized Passive Prosthetic Feet" (In Review)	-
4.34	Ghodgaonkar, A.A., Winter V, A.G. "A Manufacturing Constraint Driven Design Framework for Compact, Clog Resistant Emitter Labyrinths" (In Preparation)	-

	Publication Name	Publication Date
4.35	Van de Zande, G. D., Sheline, C., Grant, F., Pratt, S., Amrose, S., Winter V, A.G. "Design and Evaluation of an Irrigation Scheduling Tool to Bring Precision Agriculture to Resource-Constrained Farmers" (In Preparation)	-
4.36	He, W., Shah, S., Le-Henaff, A.C., Amrose, S., Winter V, A.G. "Path-Independent Desalination Performance of Time-Variant Voltage-and Flow-Controlled Electrodialysis Batch." (In Preparation)	-

5. Internal Memoranda and Progress Reports

None

6. Invited Lectures

	Publication Name	Publication Date
6.1	"Redesigning the Wheelchair," presentation at the MIT International Development Forum, April 24, 2006. Cambridge, MA.	April 2006
6.2	"Wheelchair Design in Developing Countries," Friday Speaker Series at the Sustainable International Development Programs, Heller School for Social Policy and Management, Brandeis University, February 16, 2007. Waltham, Massachusetts.	February 2007
6.3	"Wheelchair Programs at MIT," Pan African Wheelchair Builders Association Congress, September 19, 2007. Moshi, Tanzania.	September 2007
6.4	"Biologically-Inspired Methods for Burrowing and Anchoring into Undersea Substrates," Tufts University Department of Mechanical Engineering Seminar Series, October 29, 2009. Medford, MA.	October 2009
6.5	"The MIT Mobility Lab and the Leveraged Freedom Chair (LFC)," ASME Engineering for the Developing World Summit, National Academy of Sciences. March 16, 2010. Washington, DC.	March 2010
6.6	"The Leveraged Freedom Chair and Technology in the Developing World," Future of Technology Conference, Taubman College of Architecture and Urban Planning, University of Michigan, Ann Arbor. September 24, 2010. Ann Arbor, MI.	September 2010
6.7	"Razor Clam to RoboClam: Burrowing Drag Reduction Mechanisms and their Robotic Adaptation," The Robotics Institute, Carnegie Mellon University, Foundations of Robotics Seminar, Nov. 10, 2010. Pittsburgh, PA.	November 2010
6.8	"Design and Implementation of the Leveraged Freedom Chair: Innovating and Commercializing Appropriate Technology." Indian Institute of Technology Delhi, Department of Mechanical Engineering, Innovation Training Workshop, Dec. 13, 2010. Delhi, India.	December 2010
6.9	"Razor Clam to RoboClam: Biologically Inspired Mechanisms for Subsea Burrowing," Society for Integrative and Comparative Biology (SICB) annual meeting, Bioinspiration: Applying Mechanical Design to Experimental Biology symposium, Jan. 3, 2011. Salt Lake City, UT.	January 2011
6.10	"Global Design in Highly Constrained Environments," Mechanical Engineering Departmental Seminar Series, University of Rhode Island, Sept. 23, 2011. Kingston, RI.	September 2011
6.11	"Global Engineering: Technological Opportunities for Commercial, Social, and Scientific Impact in the Developing and Developed World," Harvard Kennedy School Center for International Development, Friday Speaker Series, Nov. 18, 2011. Cambridge, MA.	November 2011
6.12	"Global Engineering: Technological Opportunities for Commercial, Social, and Scientific Impact in the Developing and Developed World," Brief to Dr. Jeffery Wadsworth, CEO, Battelle Memorial Institute, Nov. 11, 2011. Columbus, OH.	November 2011

	Publication Name	Publication Date
6.13	“The Leveraged Freedom Chair: Using Stakeholder Feedback and Engineering Research to Reinvent the Wheelchair in the Developing World,” ASME IMECE Congress, Track 22-3-4 Global Outreach: Volunteering in Developing Communities, Nov. 15, 2011. Denver, CO.	November 2011
6.14	“Global Engineering: Technological Opportunities for Commercial, Social, and Scientific Impact in the Developing and Developed World,” Continuum Global Staff Meeting, Feb. 6, 2012. West Newton, MA.	February 2012
6.15	“Designing for Highly Constrained Environments: from the Deep Sea to the Developing World.” Hatsopoulos Microfluids Laboratory 10th Anniversary Celebration, Faculty Alumni Talks, April 4, 2012. Cambridge, MA.	April 2012
6.16	“Biologically Inspired Systems for Subsea Burrowing.” 10th International Mine Warfare Technology Symposium, May 8, 2012. Virtual.	May 2012
6.17	“The Leveraged Freedom Chair: Using Science, Engineering, and Stakeholder-Driven Design to Reinvent the Wheelchair in the Developing World.” TEDxBoston, June 22, 2012. http://www.ted.com/talks/amos_winter_the_cheap_all_terrain_wheelchair.html . Boston, MA.	June 2012
6.18	“Biologically Inspired Subsea Burrowing Systems.” Battelle Day at MIT, June 1, 2012. Cambridge, MA.	June 2012
6.19	“The Leveraged Freedom Chair: a Collaboration Between MIT, Pinnacle Industries, and Jaipur Foot.” Presentation to the Chief Minister of Madhya Pradesh, India, July 10, 2012. Indore, India.	July 2012
6.20	“Science, Technology, and Social Entrepreneurship in Emerging Markets,” American Society of Mechanical Engineers Board of Governors Meeting, July 19, 2012. Washington, DC.	July 2012
6.21	Infinite Innovation, Vision of the Future Section, Inauguration Symposia for MIT President L. Rafael Reif, Sept. 19, 2012. Cambridge, MA.	September 2012
6.22	“Engineering, Science, and Social Entrepreneurship in Emerging Markets,” Keynote talk for the The Indus Entrepreneurs (TiE) Boston Forum for Social Entrepreneurs, Oct. 27, 2012. Cambridge, MA.	October 2012
6.23	“Global Engineering and Research Lab,” Overview of research activities, presented to Ratan Tata, Chairman of the Tata Group, Oct. 25, 2012. Cambridge, MA.	October 2012
6.24	“The Global Engineering and Research (GEAR) Lab,” Society for Women Engineers – Engineering For Change Connect Event, 2012 Society for Women Engineers Annual Conference, Nov. 9, 2012. Houston, TX.	November 2012
6.25	“Razor Clam to RoboClam: Creating Biologically Inspired Subsea Burrowing Systems,” Northeastern University Marine Science Center Seminar 2012 Fall Seminar Series, Nov. 29, 2012. Boston, MA.	November 2012
6.26	“Making a Social Impact through Engineering Research, Science, and Innovation,” ASME Social Meetup for Early Career Engineers, 2012 ASME International Mechanical Engineering Congress and Exposition, Nov. 11, 2012. Chicago, IL.	November 2012
6.27	“Global Engineering and Research,” company-wide seminar for Mahindra. Chennai, India.	January 2013
6.28	“Leveraging Stakeholder-Driven Design, University Partnerships, and Engineering Research to Create Assistive Technologies in Developing Countries,” International Society for Prosthetics and Orthotics World Congress. Hyderabad, India.	February 2013
6.29	“Using Engineering Science and Technology Creation to Impact Emerging Markets,” MIT Mechanical Engineering Alumni Breakfast. Cambridge, MA.	March 2013

	Publication Name	Publication Date
6.30	"Using Innovation, Engineering Research, and Education to Make a Social Impact in Developing and Emerging Market," Boston University Engineering and Design Club Seminar Series. Boston, MA.	April 2013
6.31	"Using Innovation, Engineering Research, and Education to Make a Social Impact in Developing and Emerging Markets," Inquiries in Engineering Education Seminar Series, sponsored by UIUC iFoundry, University of Illinois Urbana-Champaign. Champaign, IL.	April 2013
6.32	"From Undersea Burrowing to Developing World Irrigation: Using Biologically-Inspired Fluid Systems in Highly Constrained Environments," Fluid Mechanics Seminar in the Department of Mechanical Science and Engineering, University of Illinois Urbana-Champaign. Champaign, IL.	April 2013
6.33	"Solving Intractable Challenges in Developing and Emerging Markets through the Convergence of Machine Design, Product Design, and Mechanics Research," Special Seminar in the Department of Mechanical Engineering, Stanford University. Stanford, CA.	May 2013
6.34	"Global Engineering," MIT Global Fellows Program. Cambridge, MA.	June 2013
6.35	"Solving Intractable Challenges in Developing and Emerging Markets Through the Convergence of Machine Design, Product Design, and Mechanics Research," Forum on Groundbreaking Research in Engineering Design: Fueling Growth in Emerging Markets, ASME IDETC/CIE. Portland, OR.	August 2013
6.36	"Innovation and Design for Emerging Markets," company-wide seminar for Mahindra. Chennai, India	August 2013
6.37	"Water Work in GEAR Lab: Irrigation and Purification," MIT Water Club. Cambridge, MA.	September 2013
6.38	"Emerging Technologies for Emerging Markets," EmTech, Innovators Under 35. Cambridge, MA.	October 2013
6.39	"Reinventing Markets for Automotive Technologies," MIT @ F1, Formula 1 United States Grand Prix. Austin, TX.	November 2013
6.40	"How Academia and Social Enterprise can Impact Developing/Emerging Markets," ASME Board of Governors Meeting. Washington, DC.	November 2013
6.41	"Engineering Innovation, Research, and Entrepreneurship in Emerging Markets," ASME Webinar: Engineering for the Developing World. Virtual.	November 2013
6.42	"Subsea Burrowing to Developing World Irrigation: Using Biologically-Inspired Fluid Systems in Highly Constrained Environments," Fluid Dynamics Reviews Seminar, Dept. of Mechanical Engineering, University of Maryland. College Park, MD.	December 2013
6.43	"Constraint-Driven Innovation: Creating Global Impact by Addressing Emerging Market Challenges," Boston Scientific Executive Retreat. Andover, MA.	February 2014
6.44	"Constraint-Driven Innovation: Creating Global Impact by Addressing Emerging Market Challenges," Seminar at Smith and Nephew Corporation	February 2014
6.45	"Design for Developing/Emerging Markets," Thayer School of Engineering, Dartmouth College. Hanover, NH.	March 2014
6.46	"Biologically inspired mechanical systems for highly constrained environments," Nonlinear Science and Mathematical Physics Seminar Series, Georgia Tech. Atlanta, GA.	March 2014
6.47	"Biologically inspired mechanical systems for highly constrained environments," Integrated Bioscience Seminar Series, University of Akron. Akron, OH.	April 2014

	Publication Name	Publication Date
6.48	"Engineering Global Development: Using Technical and Socioeconomic Constraints to Drive Innovation for □Developing and Developed Countries," Development Impact Lab DevTech Seminar Series, UC Berkeley. Berkeley, CA.	April 2014
6.49	"Engineering Global Development: Using Technical and Socioeconomic Constraints to Drive Innovation for □Developing and Developed Countries," Engineering Seminar, University of Luxembourg. Luxembourg.	June 2014
6.50	"Engineering Global Development: Using Emerging Market Constraints to Drive Global Innovation," Keynote, 21st International Product Development Management Conference, University of Limerick. Limerick, Ireland.	June 2014
6.51	"Power Projects in GEAR Lab," MIT Energy Initiative Advisory Board Annual Meeting. Cambridge, MA.	October 2014
6.52	"Engineering Reverse Innovation," TEDxBoston: Revolutionary Ideas Revisited, https://www.youtube.com/watch?v=48oiapTn3K0 . Boston, MA.	October 2014
6.53	"Leveraging Academic Research to Create Globally Disruptive Technologies," Engineering for Global Development Forum, 2014 ASME International Mechanical Engineering Congress & Exposition. Buffalo, NY.	November 2014
6.54	"Helping People with Disabilities Get Off Road and On with Their Lives", Invited Seminar, President's Commission on the Status of People with Disabilities, University of New Hampshire. Durham, NH.	November 2014
6.55	"Engineering Global Development: Using Emerging Market Constraints to Innovate Global Solutions", Invited Seminar, Tata Center for Technology and Design, Indian Institute of Technology Bombay. Mumbai, India.	January 2015
6.56	"Grassroots + High-Tech to Create Globally Disruptive Technologies", Third International Conference on Creativity and Innovations at Grassroots, Indian Institute of Management. Ahmedabad, India.	January 2015
6.57	"Engineering Global Development: Using Emerging Market Constraints to Innovate Global Solutions", 7th International Workshop on Design Theory, Special interest Group of the Design Society, Mines ParisTech, Paris. Paris, France.	January 2015
6.58	"How to Impact Two Billion People with Fluid Mechanics: Addressing Challenges Related to Clean Water and Irrigation in Global Development", Fluid Mechanics Seminar, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign. Champaign, IL.	February 2015
6.59	"Engineering Global Development: Using Emerging Market Constraints to Drive the Innovation of Global Technologies," Wolfson School, Loughborough University. Loughborough, UK.	March 2015
6.60	Reverse Innovation Panel, Plenary Talks - Rethinking Global Health at MIT Workshop. Cambridge, MA.	May 2015
6.61	"Research on Water Purification and Irrigation in the MIT GEAR Lab," USAID Water Team. Washington, DC.	May 2015
6.62	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies," Dept. of Mechanical Engineering, University of Toronto.	September 2015
6.63	"Engineering Global Development: Using Emerging Market Constraints to Drive the Innovation Global Technologies," PepsiCo retreat, Valhalla, NY.	October 2015
6.64	"Short Course on Engineering Products for Developing and Emerging Markets," PepsiCo, Valhalla, NY.	December 2015

	Publication Name	Publication Date
6.65	"Engineering Reverse Innovations", guest lecture at Harvard Business School with Vijay Govindarajan, Cambridge, MA.	March 2016
6.66	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies." Mechanical Engineering Graduate Seminar, Brigham Young University, Provo, UT.	March 2016
6.67	"Using developing world constraints to create a global wheelchair product," Design of Medical Devices Conference, Minneapolis, MN.	April 2016
6.68	"Using Electrodialysis to Create Low-cost, High-efficiency Brackish Groundwater Desalination Solutions for Developing Countries." MIT-JWAFS Conference: Advances in Water Purification, MIT, Cambridge, MA.	April 2016
6.69	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies" Northwestern University, ME-512 Seminar, Evanston, IL.	April 2016
6.70	"Using the Constraints of Emerging Markets to Create High-Performance, Low-Cost Assistive Devices." Rehabilitation Institute of Chicago, Research Seminar Series Presentation, Chicago, IL.	April 2016
6.71	Reverse Innovation Panel & Plenary Talk, Rethinking Global Health at MIT Workshop, MIT, Cambridge, MA.	May 2016
6.72	"Design of Solar Powered Electrodialysis Desalination Systems for India and Gaza" TED-Style Talk & Poster Marketplace, Agriculture Innovation Investment Summit, USAID; Washington, D.C.	June 2016
6.73	"Clean Water by Design in Rural India" Reddit AskScience MIT AMA. Virtual.	July 2016
6.74	"Water/Agriculture Research in GEAR Lab: Electrodialysis Desalination, Drip Irrigation, Single Cylinder Turbocharged Engines, Small Tractors." Tata Center Symposium, MIT, Cambridge, MA.	September 2016
6.75	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies," Gates Foundation, Seattle, WA.	September 2016
6.76	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies ", Oregon State University, Corvallis, OR.	September 2016
6.77	"Using emerging market constraints to create high-performance, low-cost assistive devices", Human Engineering Research Laboratories, University of Pittsburgh; Pittsburgh, PA.	November 2016
6.78	"Engineering Global Development: Using Emerging Markets Constraints to Drive the Innovation of Global Technologies", Segal Design Institute, McCormick School of Engineering, Northwestern University, Evanston, Illinois.	November 2016
6.79	"Engineering Reverse Innovations: Using Emerging Markets Constraints to Drive The Creation Of High-Performance, Low-Cost, Global Technologies." University of Toronto Global Engineering Week, Toronto, Canada	March 2017
6.80	"Engineering Reverse Innovations: Using Emerging Markets Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." MIT ILP Vienna Conference: Mind the Gap – Technological Leaps VS. Strategic Steps. Vienna, Austria.	March 2017
6.81	"Engineering Reverse Innovations: Using Emerging Markets' Constraints to Drive The Creation Of High-Performance, Low-Cost, Global Technologies." SciTech Café, Northampton, MA.	April 2017
6.82	"Engineering Reverse Innovations: Using Emerging Markets' Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." Special Seminar in Mechanical Engineering, University of Southern California, Los Angeles, CA.	October 2017

	Publication Name	Publication Date
6.83	"Engineering Reverse Innovations: Using Emerging Markets' Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." Mechanical Engineering Departmental Seminar, University of California, Los Angeles, Los Angeles, CA.	October 2017
6.84	"New Innovations and Future Directions Related to Water Technology in the MIT Global Engineering and Research (GEAR) Lab." Special Seminar given to the Water Group, USAID, Washington, D.C.	October 2017
6.85	"New Innovations and Future Directions Related to Water Technology in the MIT Global Engineering and Research (GEAR) Lab." Special Seminar, Inter-American Development Bank, Washington, D.C.	October 2017
6.86	"Pursuing an Academic Career in Global Development: Thoughts on Structuring Novel Research, Raising Funding, and Disseminating Technology." Special Seminar Given Presented by the Development Impact Lab, University of California, Berkeley, Berkeley, CA.	November 2017
6.87	"Engineering Global Development: Using Emerging Markets' Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." Liu Memorial Lecture, Department of Mechanical Engineering, Stanford University, Stanford, CA.	November 2017
6.88	"Engineering Global Development: Using Emerging Markets' Constraints to Drive the Innovation of High-Performance, Low-Cost, Global Technologies" MIT DaVinci Lecture, Cambridge, MA.	November 2017
6.89	"Engineering Global Development: Using Emerging Markets' Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." Dept. of Mechanical Engineering Seminar, Georgia Tech, Atlanta, GA.	November 2017
6.90	"Engineering Global Development: Using Emerging Markets' Constraints to Drive the Creation of High-Performance, Low-Cost, Global Technologies." Special Seminar, Global Good (Intellectual Ventures), Seattle, WA.	November 2017
6.91	"New Innovations and Future Directions Related to Water Technology in the MIT Global Engineering and Research (GEAR) Lab." Special Seminar, Inter-American Development Bank, La Paz, Bolivia.	December 2017
6.92	"Connecting Mechanical Design to Biomechanics to Design High-Performance, Low-Cost Prosthetic Feet", Otto Bock, Foot Design Team, Vienna, Austria.	January 2018
6.93	"Using Emerging Markets' Constraints to Drive the Innovation of High-Performance, Low-Cost Agricultural Technologies", Mahindra, Executive Leadership Team, Mumbai, India	January 2018
6.94	"Engineering Global Development: Using Emerging Markets' Constraints to Drive the Innovation of High-Performance, Low-Cost, Global Technologies", Special Seminar in Mechanical Engineering, TU Delft, Delft, The Netherlands.	January 2018
6.95	"High-Performance, Low-Cost Prosthetic Feet", MIT Sports Technology Summit, Cambridge, MA.	April 2018
6.96	"Leveraging Academic Research with Emerging Market Insights to Create Reverse Innovations", Mahindra Executive Leadership Summit at MIT, Organized by the MIT Industrial Liaison Program, MIT Museum, Cambridge, MA.	May 2018
6.97	"Low-Energy, Low-Cost Drip Irrigation and Desalination Innovations from the MIT GEAR Lab", at the Inter-American Development Bank Workshop on Breakthrough Technologies for the Adaptation of Agriculture to Climate Change, Washington, DC.	June 2018

	Publication Name	Publication Date
6.98	"The Challenges of User-Centered Technology Development in the Global South", keynote address at the 2018 International Tech4Dev Conference, EPFL, Lausanne, Switzerland.	June 2018
6.99	"Designing Technologies for Developing and Emerging Markets", short course given to Sime Darby R&D team, Kuala Lumpur, Malaysia.	August 2018
6.100	"Engineering Global Development through Academic Research: Aligning Value Propositions for Science, Business, and Real-World Impact", Engineering for Global Development Research Forum Keynote, ASME IDETC/CIE Conferences, Quebec City, Canada.	August 2018
6.101	"Coupling Insights into Emerging Markets with Engineering Science to Create High-Performance, Low-Cost, Global Technologies", Mechanical Engineering Departmental Seminar, University of Michigan, Ann Arbor, MI.	October 2018
6.102	"Coupling Insights into Emerging Markets with Engineering Science to Create High-Performance, Low-Cost, Global Technologies", Mechanical Engineering Department Seminar, Massachusetts Institute of Technology, Cambridge, MA.	October 2018
6.103	"Manufacturing Considerations for Engineering Global Development", Keynote Address, ASME Impact Engineering Conference, Brooklyn, NY.	October 2018
6.104	"Coupling Insights into Emerging Markets with Engineering Science to Create High-Performance, Low-Cost, Global Technologies", Mechanical Engineering Departmental Seminar, Purdue University, West Lafayette, IN.	November 2018
6.105	"Welcome to Global Engineering", Short Course at IIT Delhi, India.	January 2019
6.106	"My Journey of Integrating Precision Engineering into Global Development", Precision Engineering Seminar, Massachusetts Institute of Technology. Cambridge, MA.	January 2019
6.107	"How can we leverage science and engineering to create low-cost technologies that make a global impact?", MIT Charter Society. Boston, MA.	April 2019
6.108	"Design Thinking and its Application to Highly-Constrained, Multifaceted Problems", Sime Darby. Kuala Lumpur, Malaysia.	August 2019
6.109	IDA Academy Webinar Series, Spring 2020 - Renewable Energy & Advanced Water Treatment Solutions: "Innovations in Solar-Powered Electrodialysis System Design & Operation". Virtual.	April 2020
6.110	Irrigation Research Overview Presentation to The Toro Company. Virtual.	April 2020
6.111	MIT Museum Firehose Chat. "Product Design for Developing and Emerging Markets". Virtual.	May 2020
6.112	MIT Lincoln Laboratories Virtual Summer Program Seminar Series. "Leveraging Technical and Socioeconomic Insights to Create Products for Developing and Global Markets". Virtual.	July 2020
6.113	MIT Lincoln Laboratories Advanced Prototype Engineering Technology Symposium. "High-Performance, Low-Cost Energy Storage and Return Prosthetic Feet Designed for Developing and Developed Countries". Virtual.	October 2020
6.114	Drylands, Deserts, and Desertification Conference. "Driving Down the Costs of Solar-Powered Electrodialysis Desalination, Drip Irrigation, and the Combination of the Two". Virtual.	November 2020
6.115	MIT Tau Beta Pi da Vinci Lecture. "The Billion Person Problem: Mechanical Engineering with and for the Developing World". Virtual.	December 2020

	Publication Name	Publication Date
6.116	Xylem-MIT Masterclass: "Design Thinking". Virtual.	January 2021
6.117	"Lightning talk on global engineering programs at MIT", CU Bolder. Virtual.	February 2021
6.118	"Global by Design: Creating Technologies for Developing and Emerging Markets", BASF Internal Seminar Series. Virtual.	March 2021
6.119	"Global by Design: Creating Technologies for Developing and Emerging Markets", Ohio State University Dept. of Mechanical Engineering Seminar. Virtual.	March 2021
6.120	"Global by Design: Creating Technologies for Developing and Emerging Markets", ETH Zurich Global Engineering Seminar Series. Virtual.	April 2021
6.121	"2.007 Overview", MIT CPW. Virtual.	April 2021
6.122	"Global by Design: Creating Products for Global Markets", Executive education program at Dartmouth Tuck School of Business for LIXIL. Virtual.	May 2021
6.123	Panel on Global Engineering, Shah Lab Expo, Purdue University. Virtual.	June 2021
6.124	"GEAR Lab Desalination Research Portfolio Overview", Davis and Shirliff. Virtual.	June 2021
6.125	"Time-Variant, Renewable-Powered Desalination", presentation to SWCC, Saudi Arabia. Virtual.	July 2021
6.126	"High-Performance, Low-Cost, Renewable-Powered Desalination and Irrigation Technologies Designed for Developed and Emerging Markets", presentation to executives at Pepsi. Virtual.	August 2021
6.127	"Development of the Leveraged Freedom Chair", Mobility Device and Provision Conference, hosted by Mobility Worldwide. Virtual.	September 2021
6.128	"Low-cost, time-variant, photovoltaic-powered electrodialysis desalination", US Bureau of Reclamation WIN Conference. Virtual.	September 2021
6.129	"Global by Design: Creating Technologies for Developing and Emerging Markets", 2021 Arab Water Forum. Virtual.	September 2021
6.130	"Designing Solar-Powered Drip Irrigation Systems to Maximize Crop Productivity and Reduce System Cost in Small to Medium Scale Farm Context", Presentation to executives in the irrigation division of The Toro Company, San Diego, CA	January 2022
6.131	"Tractor Design for Small Farms in Resource Limited Markets", presentation to CNH Industrial. Virtual.	February 2022
6.132	"Global By Design: Creating Products for Global Markets", Executive Training - Tuck School of Business, Dartmouth College. Santa Clara, CA.	May 2022
6.133	"Demonstrating the Utility and Sensitivity of The Lower Leg Trajectory Error (LLTE) Design Framework", Presentation at Dynamic Walking Conference. Madison, WI.	June 2022
6.134	"Sensitivity Investigation of The Lower Leg Trajectory Error Framework and Its Implication for The Design and Evaluation of Ankle-Foot Prostheses", Presentation at World Congress on Biomechanics. Virtual.	July 2022
6.135	"Sierra Leone Prosthetics Project", Presentation at K. Lisa Yang Center for Bionics at MIT. Cambridge, MA.	July 2022

	Publication Name	Publication Date
6.136	"High-Performance, Low-Cost Innovations to Address Water, Energy, and Agriculture Challenges in India", Presentation to the Indian Ambassador to the United States; MIT School of Engineering. Cambridge, MA.	October 2022
6.137	"Predictive Time-Variant Photovoltaic-Electrodialysis (PV-ED): A Novel Design Using Machine Learning and Control Theory", International Desalination Association 2022 World Congress. Sydney, Australia.	October 2022
6.138	"Addressing Water Scarcity at The Point-Of-Use: Innovative Design Approaches for Solar-Powered Drip Irrigation and Desalination Systems", Cairo Water Week. Cairo, Egypt.	October 2022
6.139	"Smart Irrigation and Desalination: Low-Energy, Renewable-Powered, Low-Cost Smart Irrigation and Desalination", Presentation to National Taiwan University. Virtual.	December 2022
6.140	"Low-energy, renewable-powered, low-cost smart irrigation and desalination", Presentation to USAID Water Efficiency and Conservation Program. Virtual.	January 2023
6.141	"Low-energy, renewable-powered, low-cost smart irrigation and desalination", USAID Morocco Mission briefing. Virtual.	February 2023
6.142	"Low-energy, renewable-powered, low-cost smart irrigation and desalination", Morocco Ministry of Equipment and Water. Rabat, Morocco.	February 2023
6.143	"Low-energy, renewable-powered, low-cost smart irrigation and desalination", USAID Morocco Mission, US Embassy. Rabat, Morocco.	February 2023
6.144	"Time-Variant Photovoltaic Electrodialysis(PV-ED) Desalination", Presentation to Eni about desalination technology, MIT Energy Initiative. Virtual.	May 2023
6.145	"Global By Design:Creating Technologies for Global Markets", BASF NORA Meeting. Cambridge, MA	May 2023
6.146	"Global by Design: Creating Technologies for Global Markets", MIT Womens Technology Program. Cambridge, MA	June 2023
6.147	Invited speaker at MIT Convocation. Spoke to all incoming freshmen. Cambridge, MA	August 2023

Student Thesis Summary

Degree	Total	Completed	In Progress
PhD as Supervisor	18	16	2
PhD as Reader	18	17	1
Master's	37	37	0
MEng	1	1	0
Bachelor's	40	40	0
Graduate	3	0	3
MBA	1	1	0

SUPERVISED THESES

PhD as Supervisor Theses:

- Banzaert, Amy, "Viability of Waste-Based Cooking Fuels for Developing Countries: Combustion Emissions and Field Feasibility (Currently faculty member at Wellesley College)," February 2013 (Mechanical Engineering, MIT)
- Olesnavage, Katheryn, "Optimizing prosthetic foot mechanical properties to achieve desired biomechanical performance (2017 Lemelson Student Prize Winner)," February 2018 (Mechanical Engineering, MIT)
- Buchman, Michael, "A method for turbocharging single-cylinder, four-stroke internal combustion engines," June 2018 (Mechanical Engineering, MIT)
- Wright, Natasha, "Designing photovoltaic-powered electrodialysis desalination systems for rural villages (2016 Forbes 30 under 30, 2017 Lemelson Student Prize Winner, starting a tenure track faculty position at U. Minnesota in Dec. 2019)," June 2018 (Mechanical Engineering, MIT)
- Arelekatti, Murthy, "Globally Appropriate Design of Fully Passive Prosthetic Knee Components for Above-Knee Amputees ," September 2019 (Mechanical Engineering, MIT)
- Dorsch, Daniel, "Design of High Performance Hybrid Transmissions (2016 Lemelson Student Prize Winner)," September 2019 (Mechanical Engineering, MIT)
- Diaz Lankenau, Guillermo Fabian , "Development of a Tractor Specialized to Small Farms in Low Resource Settings," February 2020 (Mechanical Engineering, MIT)
- Sokol, Julia Alexandrovna, "Parametric Design and Performance Validation of Low-Cost, Low-Pressure Drip Emitters and Irrigation Systems," September 2020 (Mechanical Engineering, MIT)
- Shah, Sahil, "Making Decentralized Desalination More Affordable Using Improved Process Design, Control, and Energy Recovery," September 2021 (Mechanical Engineering, MIT)
- Prost, Victor, "Development and Validation of a Passive Prosthetic Foot Design Framework based on Lower Leg Dynamics," September 2021 (Mechanical Engineering, MIT)
- Al-Rashed, Rashed A, "An Assessment of Community-Scale Electrodialysis Desalination Systems and Improved Scale Mitigation through Pulsed Operation," September 2022 (Mechanical Engineering, MIT)
- Van de Zande, Georgia, "Irrigation System Design for Small and Medium-Scale Farmers in East Africa," September 2023 (Mechanical Engineering, MIT)
- Petelina, Nina T, "Prosthetic Leg Design," February 2024 (Mechanical Engineering, MIT)
- Sheline, Carolyn, "Designing Renewable Irrigation Systems to Increase Reliability and Reduce System Cost in Low-and-Middle Income Context," February 2024 (Mechanical Engineering, MIT)
- Grant, Fiona, "Product Architectures for Solar-Powered Drip Irrigation Systems in the MENA Region," February 2024 (Mechanical Engineering, MIT)
- Ghodgaonkar, Aditya, "Modeling, Design, and Field Validation of Low-Energy, Low-Cost, Clogging-Resistant Inline Drip Emitters," June 2024 (Mechanical Engineering, MIT)
- Liang, ZhiYi, "Design of a Modular, Compact, Flexible Formfactor, High-Pressure Microtube On-Board Hydrogen Storage Vessel for Fuel-Cell-Electric Heavy-Duty Commercial Vehicles," June 2025 (Mechanical Engineering, MIT)
- Romero, Juan, - (Mechanical Engineering, MIT)

PhD as Reader Theses:

- Austin-Breneman, Jesse, "Aligning stakeholder interests: from complex systems to emerging markets," June 2014 (Mechanical Engineering, MIT)
- Fraser, Samuel , "A Method of Using Computer Simulation to Assess the Functional Performance of Football Boots,"

- December 2014 (Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University)
- Mkrtchyan, Armen , "Modeling distributed product development processes in small and medium enterprises," June 2015 (Aeronautics and Astronautics, MIT)
 - Mooney, Luke, "Autonomous Powered Exoskeleton to Improve the Efficiency of Human Walking," February 2016 (Mechanical Engineering (research conducted in Media Lab), MIT)
 - Taylor, David, "Tools for Managing Intermittent Water Supplies," June 2018 (Mechanical Engineering, MIT)
 - Noh, Minkyun, "Homopolar Bearingless Slice Motors with Magnet-free Rotors for Extracorporeal Life Support," August 2018 (Mechanical Engineering, MIT)
 - Simon, Kevin P., "Design Tools and Mechanisms for Progressive Cavity Pumps," November 2018 (Mechanical Engineering, MIT)
 - Nayar, Kishor, "Improving Seawater Desalination and Seawater Desalination Brine Management," December 2018 (Mechanical Engineering, MIT)
 - Carney, Matthew, "On the Design of Configurable Moment-Coupled Series Elastic Actuators for Knee and Ankle Powered Prostheses," June 2019 (Media Lab, MIT)
 - Liang, Youzhi , "Sled Hockey Design project," February 2020 (Mechanical Engineering, MIT)
 - Wei, Quantum, "Can batch reverse osmosis systems enable cheaper water desalination?," June 2020 (Mechanical Engineering, MIT)
 - Meroueh, Laureen, "Effects of aluminum alloy microstructure on hydrogen generation through liquid metal activation," August 2020 (Mechanical Engineering, MIT)
 - Rogers, Emily, "Variable Stiffness Ankle-Foot Prosthesis ," February 2023 (Mechanical Engineering, MIT)
 - Bouma, Andrew, "Reducing the Energy Requirements for Brine Concentration," June 2023 (Mechanical Engineering, MIT)
 - John Romanishin, "Modular Robot Design," September 2023 (Mechanical Engineering)
 - Du, Lucy, "Design of a Series-Elastic, Cycloidal-Drive Ankle Prosthesis," February 2024 (Mechanical Engineering)
 - Nawrot, Michael, "An Integrated Approach to Instrumenting, Modeling, and Controlling Mechatronic Interventions in Human Gait," June 2024 (Mechanical Engineering (research conducted in the Media Lab), MIT)
 - Lee, Duncan, "An Embodiment of a Variable Stiffness Foot/Ankle," June 2026 (Mechanical Engineering, MIT)

Master's Theses:

- Tao, Gregory, "Design of a low-cost autoclave for adoption in rural health posts of the developing world," June 2012 (Mechanical Engineering, MIT)
- Narang, Yashraj , "Identification of design requirements for a high-performance, low-cost, passive prosthetic knee through user analysis and dynamic simulation," June 2013 (Mechanical Engineering, MIT)
- Mooney, Luke, "The use of series compliance and variable transmission elements in the design of a powered knee prosthesis (Hugh Herr in Media Lab was research advisor, I was a thesis reader)," June 2014 (Mechanical Engineering, MIT)
- Wright, Natasha , "Justification of Village Scale Photovoltaic Powered Electrodialysis Desalination Systems for Rural India," June 2014 (Mechanical Engineering, MIT)
- Olesnavage, Katheryn, "Design and Evaluation of a Cantilever Beam – Type Prosthetic Foot for Indian Persons with Amputations," June 2014 (Mechanical Engineering, MIT)
- Judge, Benjamin , "Developing World Users as Lead Users: A Case Study in Engineering Reverse Innovation," October 2014 (International Design Center, SUTD)
- Dorsch, Daniel, "Design of a Biologically-Inspired Underwater Burrowing Robot with On-Board Actuation," February 2015 (Mechanical Engineering, MIT)
- Arelekatti, Murthy, "Design of low-cost, high-performance prosthetic knee for persons with Transfemoral Amputation in India," June 2015 (Mechanical Engineering, MIT)
- Taylor, Katherine , "Bio-Inspired Low-Energy Pressure-Compensating Drip Irrigation Emitter Design (named one of Technology Review's 35 innovators under 35 in 2017)," June 2015 (Mechanical Engineering, MIT)
- Ricks, Sean, "A Discussion of the Development Process, Identification of Design Requirements, and Implementation of Improvements to a Point-of-Use Water Purifier in India," June 2015 (Mechanical Engineering, MIT)
- Isava, Monica, "An Investigation of the Critical Timescales Needed for Digging in Wet and Dry Soil Using a Biomimetic Burrowing Robot," June 2015 (Mechanical Engineering, MIT)
- Buchman, Michael, "A Low-Cost Method of Turbocharging Single-Cylinder Internal Combustion Engines to Improve Specific Power and Reduce Mechanical Engine Losses," June 2015 (Mechanical Engineering, MIT)
- Shamshery, Pulkit , "The design of low-pressure, pressure-compensated on-line drip emitters," June 2016 (Mechanical Engineering, MIT)

- O'Connor, Catherine , "Decentralized Water Treatment in Urban India, and the Potential Impacts of Reverse Osmosis Water Purifiers," June 2016 (System Design and Management, MIT)
- Diaz Lankenau, Guillermo Fabian , "The mechanics of tractor performance and their impact on historical and future device designs," February 2017 (Mechanical Engineering, MIT)
- Watson, Sterling , "Optimizing photovoltaic power systems for village-scale electrodialysis desalination (co-advised with Tonio Buonassisi) ," June 2017 (Mechanical Engineering, MIT)
- Bian, David, "Optimizing the integration of photovoltaic power systems with electrodialysis for lowest total capital cost," June 2017 (Mechanical Engineering, MIT)
- Shah, Sahil , "The Design of a Home -Use Electrodialysis Desalination System," June 2017 (Mechanical Engineering, MIT)
- Narain, Jaya , "A hybrid computational and analytical model of irrigation drip emitters," June 2017 (Mechanical Engineering, MIT)
- Prost, Victor, "Experimental Validation of the Lower Leg Trajectory Error, an Optimization Metric for Prosthetic Feet," September 2017 (Mechanical Engineering, MIT)
- Grant, Fiona R., "Development and Validation of a Systems-Level Cost Optimization Tool for Solar-Powered Drip Irrigation Systems for Smallholder Farms," June 2019 (Mechanical Engineering, MIT)
- Le Henaff, Anne-Claire , "Time-Variant Solar-Powered Electrodialysis Reversal Desalination for Affordable Off-Grid Clean Water Supply," September 2019 (Mechanical Engineering, MIT)
- Petelina, Nina T., "Exploring the Role of Damping in a Passive Prosthetic Knee through Modeling, Design, and Testing," September 2019 (Mechanical Engineering, MIT)
- Sheline, Carolyn, "Lowering the Cost of Solar-Powered Drip Irrigation Systems for Smallholder Farmers Through Systems-Level Modeling, Optimization, and Field Testing," September 2019 (Mechanical Engineering, MIT)
- Donlon, Elliott S., "Assessment of High-Value Near-Term Engineering Innovations for Indian Sanitation," September 2020 (Mechanical Engineering, MIT)
- Varner, Hannah Martin, "Architecture and Unit Design of a Capital Cost Optimized, Household Electrodialysis Desalination Device with Continuous Flow," September 2020 (Mechanical Engineering, MIT)
- Connors, Grace, "Predictive Time-Variant Solar-Powered Electrodialysis Reverseal Desalination for Affordable Off-Grid Clean Water Supply," June 2021 (Mechanical Engineering, MIT)
- Liang, ZhiYi, "Technoeconomic Framework for Designing Solar Groundwater Pumping System Architecture in Sub-Saharan Africa," June 2021 (Mechanical Engineering, MIT)
- Peterson, Heidi Victoria, "Design of a Novel Mechatronic System to Test Prosthetic Feet Under Specific Walking Activity Loads and Evaluate their Lower Leg Trajectory Error," August 2021 (Mechanical Engineering, MIT)
- Bessett, Jonathan, "Simple, Sustainable, Straight from the Sun - Batteryless Electrodialysis Desalination," June 2022 (Mechanical Engineering, MIT)
- Folinus, Charlotte Mery, "Design and Mechanical Validation of Commercially Viable, Personalized Passive Prosthetic Feet," June 2022 (Mechanical Engineering, MIT)
- Easley, Jacob Nathaniel, "Design of Integrated Desalination and Drip Irrigation System," June 2022 (Mechanical Engineering, MIT)
- Tran, Jimmy, "Design of a Larger-Scale Low-Cost Desalination System for Remote Communities," June 2023 (Mechanical Engineering, MIT)
- Goldbach, Collin, "Designing Commercial Agriculture Machinery for Resource Constrained Agriculture," September 2023 (Mechanical Engineering, MIT)
- Irani, Urvaksh, "Design of a Low-Cost High-Performance Prosthetic Foot Compatible with International Standards," September 2023 (Mechanical Engineering, MIT)
- Brei, Melissa, "Co-design of Community Desalination in the Navajo Nation," September 2023 (Mechanical Engineering, MIT)
- Costello, Jeffrey, "Economic Analysis of Cost-Optimal Electrodialysis System Design Theory for Global Markets," June 2024 (Mechanical Engineering, MIT)

MEng Theses:

- Ingersoll, Samuel, "Computer Science Aspects of Drip Irrigation ," June 2023 (Electrical Engineering and Computer Science, MIT)

Bachelor's Theses:

- Dorsch, Daniel, "The design of a fluidized bed for testing of a robotic burrowing device which mimics razor clams," June 2012 (Mechanical Engineering, MIT)

- Nawrot, Michael, "AUV tailcone architecture concept study," June 2012 (Mechanical Engineering, MIT)
- Isava, Monica , "Exploring the timescale limitations of RoboClam: a biologically inspired burrowing robot," June 2013 (Mechanical Engineering, MIT)
- Warren, Anne, "Optimizing Pressure Compensation Through Variable Area for Implementation in Low-Cost Valves for Drip Irrigation in Developing Countries," June 2013 (Mechanical Engineering, MIT)
- Ceri, Casandra, "A material analysis and dynamics study of a multi-axis of rotation trans-femoral prosthesis for developing countries," June 2013 (Mechanical Engineering, MIT)
- Kuntz, Laura, "Wick Irrigation Systems for Subsistence Farming," June 2013 (Mechanical Engineering, MIT)
- Martin, Ian, "Design and Manufacturing Practices for Pressure - Compensating Compliant Tubes," June 2014 (Mechanical Engineering, MIT)
- Avila, Elliot, "Design of a Large Cargo Bicycle Attachment for Lagos," June 2014 (Mechanical Engineering, MIT)
- Van de Zande, Georgia , "Removal rates of electrolytes commonly found in brackish groundwater by means of electrodialysis reversal desalination," June 2015 (Mechanical Engineering, MIT)
- Lin, Teresa (Teresa Ye), "Design and experimental study on pressure compensating emitters in drip irrigation," June 2015 (Mechanical Engineering, MIT)
- Esparza, Marcos, "Design for Low Power Irrigation Systems for Small Plot Farming in Eastern India," June 2015 (Mechanical Engineering, MIT)
- Guitron, Steven, "Parameters that Affect the Digging of a Biologically-Inspired Underwater Burrowing Robot," June 2015 (Mechanical Engineering, MIT)
- Antonini, Amado, "Characterization of Synchronizer Performance for a Clutchless Transmission," June 2016 (Mechanical Engineering, MIT)
- Johnson, Eric, "Self-Installation of Drip Irrigation Emitters for Prototype Emitter Testing," June 2016 (Mechanical Engineering, MIT)
- James, Bassey, "Comparison of User Metabolic Efficiency between Traditional and Spring Assisted Leveraged Freedom Chair Models," June 2016 (Mechanical Engineering, MIT)
- Bray, Samantha, "Analysis and Design of a Formula SAE Powertrain," June 2016 (Mechanical Engineering, MIT)
- Swaminathan, Krithika, "Analysis and optimization of passive knee prosthetic design parameters over varying cadences," June 2017 (Mechanical Engineering, MIT)
- Doan, David, "A Cost Optimization of Solar-Powered, Low-Cost Drip Irrigation Systems," June 2017 (Mechanical Engineering, MIT)
- Wanek, Brian, "Design of a Formula SAE electric powertrain," June 2017 (Mechanical Engineering, MIT)
- Porter, Elizabeth, "Design of a mechanical system for tillage tool depth control on small farm tractor," June 2017 (Mechanical Engineering, MIT)
- Ward-Santos, Orlando, "Design and analysis of a turbocharged single cylinder diesel engine intake system for increased power output and transient response," June 2017 (Mechanical Engineering, MIT)
- Schmidt, Kristina, "After Treatment and Turbocharger Effects on Emissions of a Diesel Engine," June 2017 (Mechanical Engineering, MIT)
- Mellow, Henry, "Design and analysis of a battery pack enclosure for Formula SAE," June 2017 (Mechanical Engineering, MIT)
- McCoy, Colleen, "Fuel economy of a turbocharged, single-cylinder, four-stroke engine," June 2017 (Mechanical Engineering, MIT)
- Harris, Jimmie, "Models to predict dynamic response of motorcycles with a outrigger & trailer," June 2017 (Mechanical Engineering, MIT)
- Gerasimoff, Steven A., "Open Wheel Racecar Steering," June 2017 (Mechanical Engineering, MIT)
- Matthews, Samuel, "Design and Implementation of a Testing Apparatus for Prosthetic Feet," June 2018 (Mechanical Engineering, MIT)
- Mora, Luis Alberto, "Design of a FSAE Braking System," June 2018 (Mechanical Engineering, MIT)
- Harvey, William, "Maximizing a Formula SAE Vehicle's Suspension Kinematics," June 2018 (Mechanical Engineering, MIT)
- Luu, Trang, "Solid Particles Flow Through Labyrinth Channels in Drip Emitters," June 2018 (Mechanical Engineering, MIT)
- Sweeney, Katelyn, "Development of a Gear Shift Test Setup for Hybrid Transmission Vehicles," June 2018 (Mechanical Engineering, MIT)
- Zeidman, Gal, "Prosthetic Knee Lock Tester," June 2019 (Mechanical Engineering, MIT)
- Edirisinghe, Thulith Suwanaka , "Automated solar and battery sizing algorithm using load, weather, technical, and

economic data that optimizes for system economics," June 2019 (Mechanical Engineering, MIT)

- Villapando, Alyanna Zsalee G., "Membrane Deflection in Inline Drip Emitters," June 2019 (Mechanical Engineering, MIT)
- McLaurin, Tristan, "Effect of Geometry under Emitter Membrane on Pressure Compensating Performance," June 2019 (Mechanical Engineering, MIT)
- Liang, ZhiYi, "Mechatronic Design of an ISO 22675 Prosthetic Foot Tester," June 2019 (Mechanical Engineering, MIT)
- Melendez, Alvaro J., "Design of a Power Limiter for an FSAE Electric Racecar ," June 2019 (Mechanical Engineering, MIT)
- McKellar, Fiona, ""A Universal Assistive Door Unlatching Device"," June 2020 (Mechanical Engineering, MIT)
- Gaither, Audrey, ""Vehicle Dynamics on an Electric Formula SAE Racecar"," June 2021 (Mechanical Engineering, MIT)
- Lee, Duncan, "Design and Clinical Evaluation of a Digital Transtibial Prosthetic Interface," May 2022 (Mechanical Engineering, MIT)

Graduate Theses:

- Weizer, Benjamin T., - (Mechanical Engineering, MIT)
- Costello, Jeffrey Dennis, - (Mechanical Engineering, MIT)
- Geil, Autumn Rose Louise, - (Mechanical Engineering, MIT)

MBA Theses:

- Daniel R Reilly, "Implementing Virtual Reality Digital Twins in the Automotive Industry," June 2021 (LGO, MIT)

Postdoctoral Associates and Fellows Supervised by Amos G. Winter, V**CURRENT POSTDOCTORAL ASSOCIATES**

Name	Appointment Start	Appointment End	PhD Granting Institution
Sheline, Carolyn	2/1/2024	12/1/2024	MIT

PREVIOUS POSTDOCTORAL ASSOCIATES

Name	Current Title	Current Employer
Sokol, Julia	Senior R&D Mechanical Engineer	Form Energy, Inc.
Gelmini, Simone	Senior Engineering Analyst	Cruise
Honarparvar, Soraya	Senior Engineer	Aspen Technology
Conforti, Kameron Michael	Senior Research Engineer	Saint-Gobain
Buchman, Michael	Sr. Mechanical Engineer	EtaGen, Inc.
Wright, Natasha Catherine	Assistant Professor	University of Minnesota
He, Wei	Royal Academy of Engineering Research Fellow	University of Warwick
Johnson, William Brett	Research Engineer	Center for the Intrepid
Ramanujan, Devarajan	Assistant Professor - Design Research	Aarhus University, Denmark
Wang, Roger Ruo-Qian	Assistant Professor	Rutgers University
Austin-Breneman, Jesse	Assistant Professor, Mechanical Engineering	University of Michigan

Courses & Evaluations

Term	Course Number	Course Title	Teaching Role	Course Type	Num Students Registered	Num Survey Responses	Eligible to Respond	Instructor Evaluation	Course Evaluation	Rating Scale
ST2010	SP.784	Wheelchair Design	Co-Instructor	Lecture	9	7	9	6.4	6.4	1 (Very Poor) - 7 (Excellent)
FT2012	2.009	Product Engineering Process	Silver Team Instructor	Lab	140	60	140	4.8	6.5	1 (Very Poor) - 7 (Excellent)
FT2012	2.009	Product Engineering Process	Red Team Instructor	Lab	140	60	140	6.0	6.5	1 (Very Poor) - 7 (Excellent)
ST2013	2.007	Design and Manufacturing I	Lab Instructor	Lab	179	85	179	6.8	5.5	1 (Very Poor) - 7 (Excellent)
ST2013	2.007	Design and Manufacturing I	Lecturer	Lecture	179	85	179	6.7	5.5	1 (Very Poor) - 7 (Excellent)
FT2013	2.S999	Spec Subj: Mechanical Engr	Lecturer	Lecture	17	9	17	6.1	5.3	1 (Very Poor) - 7 (Excellent)
ST2014	2.007	Design and Manufacturing I	Lecturer	Lecture	162	97	162	6.4	6.2	1 (Very Poor) - 7 (Excellent)
ST2014	2.007	Design and Manufacturing I	Lab Instructor	Lab	162	97	162	6.8	6.2	1 (Very Poor) - 7 (Excellent)
FT2014	2.76	Global Engineering	Lecturer	Lecture	36	21	36	6.4	5.9	1 (Very Poor) - 7 (Excellent)
ST2015	2.007	Design and Manufacturing I	Lab Instructor	Lab	151	72	151	6.3	5.5	1 (Very Poor) - 7 (Excellent)
ST2015	2.007	Design and Manufacturing I	Lecturer	Lecture	151	72	151	6.4	5.5	1 (Very Poor) - 7 (Excellent)
FT2015	2.760	Global Engineering	Lecturer	Lecture	42	30	6	6.2	5.6	1 (Very Poor) - 7 (Excellent)
ST2016	2.007	Design and Manufacturing I	Lecturer	Lecture	151	101	151	6.4	6.0	1 (Very Poor) - 7 (Excellent)
ST2016	2.007	Design and Manufacturing I	Lab Instructor	Lab	151	101	151	6.3	6.0	1 (Very Poor) - 7 (Excellent)
FT2016	2.760	Global Engineering	Lecturer	Lecture	51	38	15	6.4	5.9	1 (Very Poor) - 7 (Excellent)
ST2017	2.007	Design and Manufacturing I	Lab Instructor	Lab	163	123	163	6.9	5.8	1 (Very Poor) - 7 (Excellent)
ST2017	2.007	Design and Manufacturing I	Lecturer	Lecture	163	123	163	6.6	5.8	1 (Very Poor) - 7 (Excellent)
ST2018	2.007	Design and Manufacturing I	Lab Instructor	Lab	123	76	123	6.8	6.0	1 (Very Poor) - 7 (Excellent)

Term	Course Number	Course Title	Teaching Role	Course Type	Num Students Registered	Num Survey Responses	Eligible to Respond	Instructor Evaluation	Course Evaluation	Rating Scale
ST2018	2.007	Design and Manufacturing I	Lecturer	Lecture	123	76	123	6.2	6.0	1 (Very Poor) - 7 (Excellent)
FT2018	2.760	Global Engineering	Lecturer	Lecture	47	30	16	6.7	6.2	1 (Very Poor) - 7 (Excellent)
ST2019	2.007	Design and Manufacturing I	Lecturer	Lecture	130	77	130	6.5	6.1	1 (Very Poor) - 7 (Excellent)
ST2020	2.007	Design and Manufacturing I	Lab Instructor	Lab	122	N/A	N/A	N/A	N/A	N/A
ST2020	2.007	Design and Manufacturing I	Lecturer	Lecture	122	N/A	N/A	N/A	N/A	N/A
ST2021	2.007	Design and Manufacturing I	Lecturer	Lecture	116	N/A	N/A	N/A	N/A	N/A
ST2021	2.007	Design and Manufacturing I	Lab Instructor	Lab	116	N/A	N/A	N/A	N/A	N/A
ST2022	2.007	Design and Manufacturing I	Lab Instructor	Lab	113	50	113	7.0	5.9	1 (Very Poor) - 7 (Excellent)
ST2022	2.007	Design and Manufacturing I	Lecturer	Lecture	113	50	113	6.2	5.9	1 (Very Poor) - 7 (Excellent)
FT2022	2.760	Global Engineering	Lecturer	Lecture	25	8	6	6.5	6.3	1 (Very Poor) - 7 (Excellent)
ST2023	2.007	Design and Manufacturing I	Lab Instructor	Lab	93	35	93	7.0	5.5	1 (Very Poor) - 7 (Excellent)
ST2023	2.007	Design and Manufacturing I	Lecturer	Lecture	93	35	93	6.3	5.5	1 (Very Poor) - 7 (Excellent)
FT2023	2.760	Global Engineering	Lecturer	Lecture	30	9	12	6.8	6.4	1 (Very Poor) - 7 (Excellent)
ST2024	2.007	Design and Manufacturing I	Lecturer	Lecture	128	53	128	6.1	5.4	1 (Very Poor) - 7 (Excellent)
ST2024	2.007	Design and Manufacturing I	Lab Instructor	Lab	128	53	128	6.8	5.4	1 (Very Poor) - 7 (Excellent)

APPENDIX B: MATERIALS CONSIDERED

In addition to all documents and references cited or referred to in my Declaration, I considered the following materials in forming my opinions:

Exhibit No.	Description
Ex. 1001	U.S. Patent No. 8,607,407 (“407Patent”)
Ex. 1002	Declaration of Robert Giachetti
Ex. 1003	<i>Curriculum Vitae</i> of Robert Giachetti
Ex. 1004	File History of U.S. 8,607,407 (App. No. 12/720,484)
Ex. 1005	U.S. Patent Publication No. 2007/0209335 to Conrad (“Conrad335”)
Ex. 1006	U.K. Patent Publication No. GB283,179 to Inventia Patent-Verwertungs-Gesellschaft (“IPVG”)
Ex. 1007	French Patent No. 497,856 to Aktiebolaget Lux (“Lux”)
Ex. 1008	U.S. Patent No. 2,149,135 to Eriksson-Jons (“Eriksson-Jons”)
Ex. 1009	French Patent No. 1,094,603 to Martelliere (“Martelliere”)
Ex. 1010	Certified English translation of French Patent No. 1,094,603 to Martelliere (“Martelliere”)
Ex. 1011	Canadian Patent No. 161,428 to Robinson (“Robinson”)
Ex. 1012	Chinese Patent Publication No. 101,061,932 to Jianan (“Jianan”)
Ex. 1013	Certified English translation of Chinese Patent Publication No. 101,061,932 to Jianan (“Jianan”)
Ex. 1014	U.S. Patent Publication No. 2006/0156508 to Khalil (“Khalil”)
Ex. 1015	U.S. Publication No. 2008/0040883 (“Beskow”)
Ex. 1016	International Publication No. WO 02/067753 to Vuijk (“Vuijk”)
Ex. 1017	Ex. C-1 to Plaintiffs’ InfringementContentions in <i>SharkNinja Operating LLC v. Dyson, Inc.</i> , No. 1:23-cv-12372 (D. Mass.)
Ex. 1018	Swiss Patent No. CH203,675 to Peter (“Peter”)
Ex. 1019	Certified English translation of Swiss Patent No. CH203,675 to Peter (“Peter”)
Ex. 1020	PCT Publication No. 2007/084543 to Butler et al. (“Butler”)

Exhibit No.	Description
Ex. 1021	Plaintiffs' Infringement Contentions in <i>SharkNinja Operating LLC v. Dyson, Inc.</i> , No. 1:23-cv-12372 (D. Mass.)
Ex. 1022	The Parties' Revised Proposed Schedule in <i>SharkNinja Operating LLC v. Dyson, Inc.</i> , No. 1:23-cv-12372 (D. Mass.)
Ex. 1023	https://www.uscourts.gov/sites/default/files/data_tables/fcms_na_distp_rofile1231.2023.pdf
Ex. 1024	Petitioners' Stipulation

APPENDIX C: CHALLENGED CLAIMS

Reference Number	Claim Limitation
Claim 1	
[1pre]	A hand vacuum cleaner comprising:
[1a]	a) a front end having a front wall and a rear end;
[1b]	b) an air flow passage extending from a dirty air inlet to a clean air outlet;
[1c]	c) a first cyclone unit positioned in the air flow passage, the first cyclone unit comprising at least one cyclone and at least one dirt collection chamber external to the cyclone chamber;
[1d]	d) the cyclone and the dirt collection chamber having an openable door, the front wall comprising the openable door, whereby, when the door is in an open position, both the cyclone and the dirt collection chamber are opened; and,
[1e]	e) a suction motor positioned in the air flow passage.
Claim 2	
[2]	The hand vacuum cleaner of claim 1 wherein the at least one cyclone has a cyclone front end, a cyclone rear end, a cyclone air inlet and a cyclone air outlet and the cyclone front end is at the front end of the hand vacuum cleaner.
Claim 3	
[3]	The hand vacuum cleaner of claim 2 wherein the cyclone air inlet and the cyclone air outlet are at the same end.
Claim 4	
[4]	The hand vacuum cleaner of claim 3 wherein the cyclone air inlet and the cyclone air outlet are at the cyclone rear end.
Claim 5	
[5]	The hand vacuum cleaner of claim 1 wherein the cyclone front end has a dirt outlet and a separation plate is mounted in facing relation to the dirt outlet.
Claim 6	
[6]	The hand vacuum cleaner of claim 5 wherein the separation plate is mounted to the door.
Claim 7	
[7]	The hand vacuum cleaner of claim 1 wherein the at least one cyclone has a cyclone axis extending longitudinally through the at least one cyclone, the hand vacuum cleaner has an axis extending

Reference Number	Claim Limitation
	from the front end to the rear end and the cyclone axis is generally parallel to the axis of the hand vacuum cleaner.
Claim 8	
[8]	The hand vacuum cleaner of claim 1 wherein the first cyclone unit is positioned forward of the suction motor.
Claim 9	
[9]	The hand vacuum cleaner of claim 1 wherein the door is removable.
Claim 10	
[10]	The hand vacuum cleaner of claim 1 wherein the door is pivotally mounted to the hand vacuum cleaner.
Claim 11	
[11]	The hand vacuum cleaner of claim 1 wherein the dirt collection chamber is removable from the hand vacuum cleaner.
Claim 12	
[12]	The hand vacuum cleaner of claim 1 wherein the dirt collection chamber is removable from the surface cleaning apparatus as a sealed unit for emptying.
Claim 13	
[13]	The hand vacuum cleaner of claim 12 wherein the first cyclone unit is sealed when removed from the hand vacuum cleaner other than fluid flow passages leading to and from the first cyclone unit.
Claim 14	
[14]	The hand vacuum cleaner of claim 1 wherein the dirt collection chamber is removable from the hand vacuum cleaner with the first cyclone unit.
Claim 15	
[15]	The hand vacuum cleaner of claim 1 wherein the first cyclone unit has a single cyclone and a single dirt collection chamber.
Claim 16	
[16]	The hand vacuum cleaner of claim 15 wherein the single dirt collection chamber is positioned exterior to the single cyclone.
Claim 17	
[17]	The hand vacuum cleaner of claim 16 wherein the single cyclone and the single dirt collection chamber comprise a one-piece assembly.
Claim 18	

Reference Number	Claim Limitation
[18]	The hand vacuum cleaner of claim 17 wherein the single cyclone and the single dirt collection chamber are integrally formed.
Claim 19	
[19]	The hand vacuum cleaner of claim 1 wherein the hand vacuum cleaner further comprises a suction motor housing, the suction motor is positioned in the suction motor housing and the first cyclone unit is removably mounted to the suction motor housing.
Claim 20	
[20]	The hand vacuum cleaner of claim 1 further comprising a second cyclone unit downstream from the first cyclone unit.
Claim 21	
[21]	The hand vacuum cleaner of claim 1 wherein the at least one cyclone has a cyclone axis extending longitudinally through the at least one cyclone and the dirt collection chamber has a perimeter at the front end and the openable door has a perimeter that is generally the same as the perimeter of the dirt collection chamber.
Claim 22	
[22]	The hand vacuum cleaner of claim 1 wherein the front wall is the openable door.
Claim 23	
[23pre]	A hand vacuum cleaner comprising:
[23a]	a) a front end having a front wall and a rear end;
[23b]	b) an air flow passage extending from a dirty air inlet to a clean air outlet;
[23c]	c) a first cyclone unit positioned in the air flow passage, the first cyclone unit comprising at least one cyclone and at least one dirt collection chamber;
[23d]	d) the dirt collection chamber having an openable door, the front wall comprising the openable door; and,
[23e]	e) a suction motor positioned in the air flow passage
[23f]	wherein the door is openable when the dirt collection chamber is mounted to the hand vacuum cleaner.
Claim 24	
[24pre]	A hand vacuum cleaner comprising:
[24a]	a) a front end having a front wall and a rear end;
[24b]	b) an air flow passage extending from a dirty air inlet to a clean air outlet;

Reference Number	Claim Limitation
[24c]	c) a first cyclone unit positioned in the air flow passage, the first cyclone unit comprising at least one cyclone and at least one dirt collection chamber;
[24d]	d) the dirt collection chamber having an openable door, the front wall comprising the openable door; and,
[24e]	e) a suction motor positioned in the air flow passage
[24f]	wherein the openable door covers an end of the dirt collection chamber.
Claim 25	
[25pre]	A hand vacuum cleaner comprising:
[25a]	a) a front end having a front wall and a rear end;
[25b]	b) an air flow passage extending from a dirty air inlet to a clean air outlet;
[25c]	c) a first cyclone unit positioned in the air flow passage, the first cyclone unit comprising at least one cyclone and at least one dirt collection chamber;
[25d]	d) the dirt collection chamber having an openable door, the front wall comprising the openable door; and,
[25e]	e) a suction motor positioned in the air flow passage
[25f]	wherein the dirt collection chamber has a rear end and the rear end is non-removably mounted to the first cyclone unit.

APPENDIX D: UNDERSTANDING OF THE LAW

I have applied the following legal principles provided to me by counsel in arriving at the opinions set forth in this declaration.

Legal Standard for Prior Art

I am not an attorney. I have been informed by attorneys of the relevant legal principles and have applied them to arrive at the opinions set forth in this declaration.

I understand that the petitioner for *inter partes* review may request the cancelation of one or more claims of a patent based on grounds available under AIA 35 U.S.C. § 102 and 35 U.S.C. § 103 using prior art that consists of patents and printed publications.

Anticipation and Prior Art

I understand that § 102 specifies when a challenged claim is invalid for lacking novelty over the prior art, and that this concept is also known as “anticipation.” I understand that a prior art reference anticipates a challenged claim, and thus renders it invalid by anticipation, if all elements of the challenged claim are disclosed in the prior art reference. I understand the disclosure in the prior art reference can be either explicit or inherent, meaning it is necessarily present or implied. I understand that the prior art reference does not have to use the same words as the challenged claim, but all of the requirements of the claim must be disclosed

so that a person of ordinary skill in the art could make and use the claimed subject matter.

In addition, I understand that § 102 also defines what is available for use as a prior art reference to a challenged claim.

Under § 102(a)(1), a challenged claim is anticipated if it was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.

Under § 102(b)(1), a challenged claim is anticipated if it was described in an issued patent or published patent application, in which the patent or application names another inventor and was effectively filed before the effective filing date of the claimed invention.

I understand that the effective filing date of a patent or patent application is the earlier of the actual filing date of the patent or the application for patent or, if the patent or application for patent is entitled to claim earlier priority or the benefit of an earlier filing, the filing date of the earliest application that describes the claimed subject matter.

I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

I understand that when a challenged claim requires selection of an element from a list of alternatives, the prior art teaches the element if one of the alternatives is taught by the prior art.

Legal Standard for Obviousness

I understand that even if a challenged claim is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the claimed subject matter would have been obvious to a person of ordinary skill in the pertinent art at the time the alleged invention.

I understand that, in order for a prior art reference to be proper for use in an obviousness analysis, the reference must be analogous art. I understand that a prior art reference is analogous art if: (1) the reference is from the same field of endeavor as the challenged patent (even if it addresses a different problem); or (2) the reference is reasonably pertinent to the problem faced by the inventor of the challenged patent (even if it is not in the same field of endeavor). I understand that the field of endeavor is determined by reference to explanations of the challenged claims' subject matter in the challenged patent, including the embodiments, functions, and structures of the challenged claims. A prior art reference is "reasonably pertinent" to a problem if it would have logically commended itself to an inventor's attention in considering the problem.

I understand that obviousness must be determined with respect to the challenged claim as a whole.

I understand that one cannot rely on hindsight in deciding whether a claim is obvious.

I also understand that an obviousness analysis includes the consideration of factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claim, (3) the level of ordinary skill in the pertinent art, and (4) “secondary” or “objective” evidence of non-obviousness.

Secondary or objective evidence of non-obviousness includes evidence of: (1) a long felt but unmet need in the prior art that was satisfied by the claimed invention; (2) commercial success or the lack of commercial success of the claimed invention; (3) unexpected results achieved by the claimed invention; (4) praise of the claimed invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the claimed invention; and (7) contemporaneous and independent invention by others. However, I understand that there must be a relationship between any secondary evidence of non-obviousness and the claimed invention.

I understand that a challenged claim can be invalid for obviousness over a combination of prior art references if a reason existed (at the time of the alleged invention) that would have prompted a person of ordinary skill in the art to combine

elements of the prior art in the manner required by the challenged claim. I understand that this requirement is also referred to as a “motivation to combine,” “suggestion to combine,” or “reason to combine,” and that there are several rationales that meet this requirement.

I understand that the prior art references themselves may provide a motivation to combine, but other times simple common sense can link two or more prior art references. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may come from market forces.

I understand obviousness to include, for instance, scenarios where known techniques are simply applied to other devices, systems, or processes to improve them in an expected or known way. I also understand that practical and common-sense considerations should be applied in a proper obviousness analysis. For instance, familiar items may have obvious uses beyond their primary purposes.

I understand that the combination of familiar elements according to known methods is obvious when it yields predictable results. For instance, obviousness bars patentability of a predictable variation of a technique even if the technique originated in another field of endeavor. This is because design incentives and other market forces can prompt variations of it, and predictable variations are not the product of innovation, but rather ordinary skill and common sense.

I understand that a particular combination may be obvious if it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. This would result in something obvious because the result is the product not of innovation but of ordinary skill and common sense. However, I understand that it may not be obvious to try a combination when it involves unpredictable technologies.

It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

It is my understanding that the Manual of Patent Examining Procedure §2143 sets forth the following as exemplary rationales that support a conclusion of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;

- Use of known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

A person of ordinary skill in the art looking to overcome a problem will often use the teachings of multiple publications together. I understand that obviousness analysis takes into account inferences, creative steps, common sense, and practical logic and applications that a person of ordinary skill in the art would employ under the circumstances.

I understand that a claim can be obvious in light of a single reference, if the elements of the challenged claim that are not explicitly or inherently disclosed in the reference can be supplied by the common sense of one of skill in the art.

I understand that obviousness also bars the patentability of applying known or obvious design choices to the prior art. One cannot patent merely substituting one prior art element for another if the substitution can be made with predictable results. Likewise, combining prior art techniques that are interoperable with respect to one another is generally obvious and not patentable.

In order for a claim to be found invalid based upon a modification or combination of the prior art, there must be reasonable expectation that a person of ordinary skill would have successfully modified or combined the prior art to arrive at the claimed arrangement. This does not mean that it must be certain that a person of ordinary skill would have been successful—the law only requires that the person of ordinary skill in the art would have perceived a reasonable expectation of success in modifying or combining the prior art to arrive at the claimed invention.

In sum, my understanding is that obviousness invalidates claims that merely recite combinations of, or obvious variations of, prior art teachings using understanding and knowledge of one of skill in the art at the time and motivated by the general problem facing the inventor at the time. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the

time of the invention, can provide a reason for combining the elements of or attempting obvious variations on prior art references in the claimed manner.

Legal Standard for Claim Construction

I understand that before any invalidity analysis can be properly performed, the scope and meaning of the challenged claims must be determined by claim construction.

I understand that a patent may include two types of claims, independent claims and dependent claims. I understand that an independent claim stands alone and includes only the limitations it recites. I understand that a dependent claim depends from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to the limitations recited in the claim (or claims) from which it depends.

In comparing the challenged claims to the prior art, I have carefully considered the patent and its file history in light of the understanding of a person of skill at the time of the alleged invention.

I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to sources available at the time of the alleged invention that show what a person of skill in the art would have understood disputed claim language to mean. It is my understanding that this may include what is called “intrinsic” evidence as well as “extrinsic” evidence.

I understand that, in construing a claim term, one should primarily rely on intrinsic patent evidence, which includes the words of the claims themselves, the remainder of the patent specification, and the prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. I understand that extrinsic evidence may include principles, concepts, terms, and other resources available to those of skill in the art at the time of the invention.

I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else or something more specific. I understand that to determine whether a term has special meaning, the claims, the patent specification, and the prosecution history are particularly important, and may show that the inventor gave a term a particular definition or intentionally disclaimed, disavowed, or surrendered claim scope.

I understand that the claims of a patent define the scope of the rights conferred by the patent. I understand that because the claims point out and distinctly claim the subject matter which the inventors regard as their invention, claim construction analysis must begin with and is focused on the claim language itself. I understand that the context of the term within the claim as well as other claims of the patent can inform the meaning of a claim term. For example, because claim terms are normally

used consistently throughout the patent, how a term is used in one claim can often inform the meaning of the same term in other claims. Differences among claims or claim terms can also be a useful guide in understanding the meaning of particular claim terms.

I understand that a claim term should be construed not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the entire specification. I understand that because the specification is a primary basis for construing the claims, a correct construction must align with the specification.

I understand that the prosecution history of the patent as well as art incorporated by reference or otherwise cited during the prosecution history are also highly relevant in construing claim terms. For instance, art cited by or incorporated by reference may indicate how the inventor and others of skill in the art at the time of the invention understood certain terms and concepts. Additionally, the prosecution history may show that the inventors disclaimed or disavowed claim scope, or further explained the meaning of a claim term.

With regard to extrinsic evidence, I understand that all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may indicate how one of skill in the art used or understood the claim

terms. However, I understand that extrinsic evidence is considered to be less reliable than intrinsic evidence, and for that reason is generally given less weight than intrinsic evidence.

I understand that in general, a term or phrase found in the introductory words or preamble of the claim, should be construed as a limitation if it recites essential structure or steps, or is necessary to give meaning to the claim. For instance, I understand preamble language may limit claim scope: (i) if dependence on a preamble phrase for antecedent basis indicates a reliance on both the preamble and claim body to define the claimed invention; (ii) if reference to the preamble is necessary to understand limitations or terms in the claim body; or (iii) if the preamble recites additional structure or steps that the specification identifies as important.

On the other hand, I understand that a preamble term or phrase is not limiting where a challenged claim defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I understand that to make this determination, one should review the entire patent to gain an understanding of what the inventors claim they invented and intended to encompass in the claims.