

**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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LULULEMON ATHLETICA CANADA INC. and LULULEMON USA INC.,  
Petitioner,

v.

NIKE, INC.,  
Patent Owner.

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Patent: 10,188,930

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**DECLARATION OF DR. GREGORY S. FISCHER, PH.D.**

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## **I. Background**

1. My name is Gregory S. Fischer, Ph.D. I have been retained by lululemon athletica canada inc. and lululemon usa inc. (“Petitioner” or “lululemon”) to assist regarding U.S. Patent No. 10,188,930 (Ex. 1001, “the ’930 patent”), which is titled “Combinatory Score Having a Fitness Sub-Score and an Athleticism Sub-Score,” by Paul T. Winsper and Kristopher L. Homs. The ’930 patent was filed on August 14, 2017, and issued on January 29, 2019. I am informed that it is currently assigned to Nike, Inc. It is my understanding that the ’930 patent’s earliest possible priority date is June 4, 2012. Specifically, I have been asked to consider the patentability of claims 1, 5-7, and 12 of the ’930 patent (“the Challenged Claims”) in view of prior art and the understanding of a person of ordinary skill in the art (“POSITA”) as it relates to the ’930 patent. I understand that my opinions in this declaration are being submitted as part of the petition in this IPR.

2. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both.

3. I am being compensated for my time at a consulting rate of \$675/hour. I am also being reimbursed for expenses that I incur during the course of this work.

My compensation is not contingent upon the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no financial interest in the outcome of this matter or in any litigation involving the '930 patent.

## **II. Qualifications**

4. I am a tenured Professor of Robotics Engineering with appointments in Mechanical Engineering and Biomedical Engineering at Worcester Polytechnic Institute (WPI). I am the founding director of the Automation and Interventional Medicine Robotics Research Laboratory (AIM Lab) at WPI and Director of PracticePoint, a research, development, and commercialization alliance and associated facility built to advance healthcare technologies and launch new medical cyber-physical systems. A core focus of the PracticePoint research and development (R&D) center includes personal and home healthcare and medical device sensing, processing, user experience, and interconnectivity.

5. I received B.S. degrees in both Mechanical Engineering and Electrical Engineering from Rensselaer Polytechnic Institute in 2002 and an M.S.E. degree in Electrical Engineering from Johns Hopkins University. I received my Ph.D. in Mechanical Engineering from Johns Hopkins University in 2008, where I was trained through a collaborative research arrangement between the NSF Engineering Research Center for Computer Integrated Surgery at Johns Hopkins and the

NAMIC Surgical Planning Laboratory at the Brigham and Women's Hospital, a Harvard Medical School affiliate.

6. My master's thesis at Johns Hopkins University was titled "Electromagnetic Tracker Characterization and Optimal Tool Design – With Applications to ENT Surgery" and was completed in 2005. This work focused on optimizing the position and orientation tracking accuracy of electromagnetically tracked instrumentation. It included characterizing and ultimately compensating for the errors due magnetic field distortion in clinical environments, as well as methods for optimizing the design of tools to enhance accuracy and minimize effects of distortion.

7. My Ph.D. dissertation at Johns Hopkins University was titled "Enabling Technologies for MRI Guided Interventional Procedures" and was completed in 2008. My dissertation focused on ways to leverage the high-quality imaging available from MRI during a surgical intervention. This work included the use of augmented reality approaches, including image overlay projections. The primary contribution of the work was on the development of a robot and associated system architecture for MRI-compatible surgical robots. I developed sensors, actuators, control electronics, mechanical robot design, control algorithms, communication framework, low-level software, high-level software, and general system architecture. The outcome was a pneumatic robot for prostate biopsy under

live MRI imaging. This work was in partnership with Brigham and Women's Hospital, with whom I have maintained a close collaboration to this day after joining WPI as a faculty member in Robotics Engineering. Latter iterations of this robot were used in clinical trials in 30 patients at the Brigham and Women's Hospital, where I spent my first sabbatical associated with the Department of Radiology.

8. My research has included NIH-funded support for robot-assisted neurosurgical intervention, robot-assisted prostate interventions, and sensor-based feedback for guiding the use of surgical fastening systems as well as NSF support for collaborative and teleoperated medical robotics. I am a PI and the Project Director on an NIH R01 grant through NCI focused on developing a system for precision conformal thermal ablation to brain tumors. This incorporates an MRI-compatible neurosurgery robot that we have developed, as well as needle-based therapeutic ultrasound instrument and real-time MRI-based thermometry. We also have done significant work in designing the robot control system electronics, software, actuators, manipulator, and other aspects. I am also a PI on an NIH R01 grant through NIBIB for cooperative control of MRI-compatible robots for image-guided prostate interventions. This approach incorporates hands-on teleoperation through force sensors on the robot and active compensation of the needle path through autonomous image-guided needle steering. I am also the co-PI

for two NSF grants supporting autonomous robotic surgery. One grant that recently completed focused on developing technology and approaches for cooperative robotics and a simulation environment. The other current grant is focused on building an international community collaborating on implementing intelligent surgical robotic systems.

9. I am also involved in a number of other projects. My research experience includes substantial work in biosensing for physiological parameters, including pulse rate and strength, blood flow and perfusion, tissue and blood oxygenation, metabolic activity, and the like. Some of this work was performed at WPI though advising student projects. Some of these projects include wearable assistive devices for shoulder, arm, hand, and lower limb assistance and rehabilitation. These assistive and rehabilitative research efforts comprised substantial biomechanics analysis of human body motion, sensors, and algorithms for measuring and analyzing motion, and development of open-source software libraries and datasets to support other groups doing related research. I have also worked on projects related to sensors such as diabetes monitoring through compact optical sensors and an automated phlebotomist that used computer vision to identify blood flow. These efforts included sensors including oxygenation, blood flow, force, EMG, eye tracking, accelerometers, computer vision, motion capture, and the like.

10. Outside of my academic endeavors, I was the founder of a medical device company that focused on surgical sensors. This company received several NIH SBIR grants to develop sensing technologies to assess tissue properties and interactions. My work with the company resulted in sensors capable of measuring tissue interactions (e.g., compression pressure), blood and tissue oxygenation, blood flow and perfusion, pulse rate and strength, temperature, and other parameters. Much of this work was focused on developing, building, and evaluating novel optical physiologic-sensing techniques. As such, I am very familiar with approaches for monitoring biomechanics and physiology using techniques associated with compact wearable sensors as well as with larger-scale research-grade commercial equipment.

11. I have been an active member of the medical device and robotics research community for 18 years with over 100 peer-reviewed publications, including over 20 journal manuscripts or book chapters in the field of medical robotics and intelligent healthcare devices. The following are select publications wherein I was an author, and in many cases the project supervisor, demonstrating my expertise. A complete listing is available in my curriculum vitae (CV) attached at the end of this Declaration.

- a) In 2022, I led the preparing of the invited article “State of the Art and Future Opportunities in MRI-Guided Robot-Assisted Surgery and

Interventions,” which was recently published in *IEEE Proceedings – Special Issue on Surgical Robotics and Interventional Systems*. This is a review paper and forward-thinking summary of the field of MRI-guided surgical interventions in a high-profile special issue.

- b) In 2022, I authored an article titled “An Open Simulation Environment for Learning and Practice of Robot-Assisted Surgical Suturing,” which was published in *IEEE Robotics and Automation Letters*. The focus of this article was on developing a full kinematic, dynamic, and visualization simulation for the surgical robotics task of suturing. The goal was to develop a simulation framework for enabling machine-learning techniques for needle tracking and suturing task automation.
- c) In 2021, I authored an article titled “Open Source Vicon Toolkit for Motion Capture and Gait Analysis,” which was published in Elsevier’s *Computer Methods and Programs in Biomedicine*. The focus of this article was the development of tools for tracking and analyzing the motion of people while performing athletic and rehabilitation activities. We developed an open-source software library for motion capture and associated analysis.

- d) In 2021, I authored an article titled “Modeling of Interstitial Ultrasound Ablation for Continuous Applicator Rotation with MR Validation,” which was published in *IEEE Transactions on Biomedical Engineering*. The focus of this article was modeling of acoustic and thermal propagation of ultrasound-based tissue heating and monitoring the results using MRI-based thermometry. The purpose of this work is precision image-guided, robot-assisted brain tumor ablation.
- e) In 2021, I authored an article titled “Toward Generalization of Bipedal Gait Cycle During Stair Climbing Using Learning from Demonstration,” which was published in *IEEE Transactions on Medical Robotics and Bionics*. The focus of this article was analyzing the motion of people performing a stair-climbing activity. The goal of this work was to learn the typical gait pattern and use it to train an exoskeleton to help someone follow that motion profile.
- f) In 2021, I authored an article titled “A Framework for Customizable Multi-User Teleoperated Control,” which was published in *IEEE Robotics and Automation Letters*. The focus of this article was developing an open-source software framework for multi-user teleoperation. The intention is to enable multiple users at multiple

sites using differing physical user input devices to coordinate interactions with each other and also a real and/or simulated environment.

- g) In 2020, I authored an article titled “An Integrated Robotic System for MRI-Guided Neuroablation: Preclinical Evaluation,” which was published in *IEEE Transactions on Biomedical Engineering*. The focus of this article was a complete system for MRI-guided, robot-assisted stereotactic interventions in the brain. Our team evaluated the robot for brain tumor ablation in preclinical studies.
- h) In 2019, I authored an article titled “System Integration and Preliminary Clinical Evaluation of a Robotic System for MRI-Guided Transperineal Prostate Biopsy,” which was published in *Journal of Medical Robotics Research*. The focus of this work was a robotic system developed for MRI-guided targeted prostate biopsy. Our team evaluated the system performing image-guided prostate biopsy in human trials.
- i) In 2019, I authored an article titled “A Method for High-Throughput Robotic Assembly of 3-Dimensional Vascular Tissue,” which was published in *Tissue Engineering*. This work focused on a robotic system for preparing artificial vasculature.

- j) In 2018, I authored an article titled “Design Criteria for Hand Exoskeletons: Measurement of Forces Needed to Assist Finger Extension in Traumatic Brain Injury Patients,” which was published in *IEEE Robotics and Automation Letters*. This work focused on using sensors to evaluate the motions and associated interaction forces of humans, and in particular hand motions of people with brain injuries. The goal of the work was to understand the forces required, so as to develop an assistive active orthosis.
- k) In 2018, I authored an article titled “Socially Assistive Robots: Current Status and Future Prospects for Autism Interventions,” which was published in *Innovation and Entrepreneurship in Health*. This manuscript reviewed socially assistive robots and approaches for human-robot interaction, sensors, actuation, control, and therapeutic techniques. This manuscript also discussed my work toward developing a socially assistive robot intended to interact with children with autism.
- l) In 2017, I authored a manuscript titled “Fiber Optic Force Sensors for MRI-Guided Interventions and Rehabilitation: A Review,” which was published in *IEEE Sensors Journal*. This is a detailed review of various sensing approaches used in medical devices for interacting

with people while inside the MRI scanner. It also addresses my work related to developing fiberoptic force sensing techniques.

- m) In 2016, I authored an article titled “Design and Characterization of a Lightweight and Fully Portable Remote Actuation System for Use with a Hand Exoskeleton,” which was published in *IEEE Robotics and Automation Letters*. This article describes a wearable sensing and actuation system that controls a soft robotic glove for assisting with activities of daily living. The related work includes analyzing user motion using accelerometers and inertial measurement units and monitoring physiologic signals such as EMG.
- n) In 2015, I authored the article titled “Tissue Changes During Operational Load Bearing in UH-60 Aircrew Using Magnetic Resonance Imaging,” which was published in *Aerospace Medicine and Human Performance*. This work assessed the effects of loading conditions on the human body and how the tissues react.
- o) In 2011, I authored an article titled “Augmented reality visualization using image-overlay for MR-guided interventions: system description, feasibility, and initial evaluation in a spine phantom,” which was published in *American Journal of Roentgenology*. This

work addressed a novel augmented reality approach to using overlaid medical images to guide needle-based interventions.

- p) In 2010, I authored the article “Implementation of an Undergraduate Robotics Engineering Curriculum,” which was published in *ASEE Computers in Education Journal – Special Issue on Robotics Education*. I was an integral member of the team in developing the first undergraduate degree program in robotics engineering in the nation, which is summarized in this manuscript.
- q) In 2009, I authored an article titled “OpenIGTLink: An Open Network Protocol for Image-Guided Therapy Environment,” which was published in *The International Journal of Medical Robotics and Computer Assisted Surgery*. This work describes our development of a new standardized open-source network communication protocol for image-guided interventions that is broadly used today.
- r) In 2006, I presented the article “Ischemia and Force Sensing Surgical Instruments for Augmenting Available Surgeon Information” at the IEEE International Conference on Biomedical Robotics and Biomechatronics. This work focused on the development of multi-modality physiology and physical interaction sensors on medical devices to assess tissue viability.

s) In 2005, I presented the article “Intra-operative Ischemia Sensing Surgical Instruments” at the International Conference on Complex Medical Engineering. This work described developing from scratch the electronics, embedded software, and physical devices for monitoring physiologic conditions of tissue.

12. I’ve also studied, researched, taught, and published on topics including kinematics, dynamics, control, biosensing, sensor electronics, signal processing, system engineering, programming including embedded systems, medical imaging, biomechanics, wearable and assistive devices, and others.

13. Overall, in addition to the aforementioned experience, my technical experience relevant to this patent at the time of the alleged invention (i.e., the ’930 patent’s earliest possible priority date of November 1, 2010) included the following: experience running biomechanics user studies, experience with systems and methods for biomechanics motion capture and analysis; experience with systems and methods for biosensing; experience with physiologic sensor design, implementation, and evaluation; familiarity with using and developing software for portable computing devices and systems of the time; and wired and wireless communication and networking between sensors, signal processors, displays, user inputs devices, and logging/recording/storage devices.

14. My service record to the community includes being very involved in the robotics, medical imaging, and biomedical engineering communities. I serve as an expert reviewer for federal grants (including NSF & NIH). I have held various editorial roles in high-profile conferences and journals in my field. I have been an organizer and session chair for conferences, workshops, tutorials, symposium, panels, and the like. My team regularly develops, posts, and supports open-source software projects that are available to the community at large. I am a lead in supporting the international open-source hardware and software community based around the daVinci Research Kit (dVRK) for intelligent surgical robotics research. And I am the Director of the state-funded PracticePoint R&D center for healthcare cyber-physical systems and help support business development in the region for companies working on various smart healthcare devices (including wearable sensors and networked monitoring applications on mobile devices).

15. I am an active inventor myself and am a Senior Member of the National Academy of Inventors. I am a named inventor on a number of U.S. and international patents and patent applications, including 10 granted U.S. patents. The following are selections from patent families, including issued U.S. patents where I am a named inventor. A complete listing is available in my CV attached at the end of this Declaration.

- a) “Surgical Head Clamp and Robotics Platform,” U.S. Patent No. 10,182,879 issued on January 22, 2019.
- b) “System and Method of Pervasive Developmental Disorder Interventions,” U.S. Patent No. 10,176,725 issued on January 8, 2019.
- c) “System and Method for Robotics Surgical Intervention in a Magnetic Resonance Imager,” U.S. Patent No. 9,844,414 issued on December 19, 2017.
- d) “System and Method for Underactuated Control of Insertion Path for Asymmetric Tip Needles,” U.S. Patent No. 10,052,458 issued on August 21, 2018, and U.S. Patent No. 11,207,500 issued on December 28, 2021.
- e) “Apparatus, systems and methods for determining tissue oxygenation,” U.S. Patent No. 9,420,967 issued on August 23, 2016.
- f) “Sensing Adjunct for Surgical Staplers,” U.S. Patent No. 8,118,206 issued on February 21, 2012.
- g) “Surgical Instruments with Sensors for Detecting Tissue Properties, and System Using Such Instruments,” U.S. Patent No. 9,204,830 issued on December 8, 2015, U.S. Patent No. 10,231,634 issued on March 19, 2019, and U.S. Patent No. 11,324,412 issued on May 10, 2022.

16. I have been deposed in other cases, but I have not testified as an expert witness at trial. The following are *inter partes* review cases that were heard by the Patent Trial and Appeal Board in which I have served as an expert.

- a) “Documentation Through a Remote Presence Robot,” Assignee: Teladoc Health, Inc., Petitioner: American Well Corporation.
- b) “Remote Presence Display Through Remotely Controlled Robot,” Assignee: Teladoc Health, Inc., Petitioner: American Well Corporation.
- c) “Robotic Based Health Care System,” Assignee: Teladoc Health, Inc., Petitioner: American Well Corporation.
- d) “Detachable Motor Powered Surgical Instrument,” Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), Petitioner: Intuitive Surgical, Inc.
- e) “Motor Driven Surgical Cutting Instrument,” Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), Petitioner: Intuitive Surgical, Inc.
- f) “Robotically-Controlled Motorized Surgical End Effector System with Rotary Actuated Closure Systems Having Variable Actuation Speeds,” Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), Petitioner: Intuitive Surgical, Inc.

- g) “Robotic System for Fastening Layers of Body Tissue Together and Method Thereof,” Assignee: PTech, LLC, Petitioner: Intuitive Surgical, Inc.
- h) “Robotic System for Engaging a Fastener with Body Tissue,” Assignee: PTech, LLC, Petitioner: Intuitive Surgical, Inc.
- i) “Robotic Fastening System,” Assignee: PTech, LLC, Petitioner: Intuitive Surgical, Inc.

17. A complete copy of my CV, which includes a list of my publications and contains further details on my education, experience, publications, patents, and other qualifications to render an expert opinion, is attached at the end of this Declaration.

### **III. Materials Considered**

18. In performing my analysis and forming the opinions below, I considered the '930 patent, its prosecution history, the applications that it incorporates by reference, and the materials listed as exhibits to the petition in this IPR.

### **IV. Understanding of Relevant Legal Principles**

19. I am not a lawyer, and I will not provide any legal opinions. Rather, I have been asked to provide my technical opinions based on how a person of ordinary skill in the art (POSITA) would have understood the claims of the '930

patent, in light of its disclosure and prosecution history, as of the patent's priority date. Although I am not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

**A. Claim Construction Standard**

20. I understand that claim terms are given their ordinary and customary meaning, as would be understood by a POSITA in the context of the patent's entire disclosure and prosecution history. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In that case, the claim term will receive the definition set forth in the patent.

**B. Anticipation and Obviousness**

21. I understand that a patent claim is invalid if it is anticipated or obvious in view of the prior art. I further understand that invalidity of a claim requires that the claim be anticipated or obvious from the perspective of a POSITA at the time the invention was made.

22. I have been informed that a patent claim is invalid if it would have been obvious to a POSITA. In analyzing the obviousness of a claim, I understand the following factors may be taken into account: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of

ordinary skill in the art; and (4) any so-called “secondary considerations” of non-obviousness if they are present. I am not aware of any evidence of secondary considerations of non-obviousness relevant to the patent. I reserve the right to supplement this Declaration if Patent Owner introduces evidence of secondary considerations of non-obviousness.

23. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. I further understand that exemplary rationales that may support a conclusion of obviousness include:

- 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(s) 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;
- “obvious to try” – 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 the work for use in either the same field or a different field based on design incentives or other market forces if the variations are predictable to a POSITA; and
- some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to prior art reference teachings to arrive at the claimed invention.

24. I have been informed that, in considering obviousness, hindsight reasoning derived from the patent-at-issue may not be used.

## **V. Background**

### **A. Technical Background**

25. Advances in technologies (e.g., smartphones, wearables) have made it possible for people to monitor and track many daily activities such as exercise, eating, and health. People gained access to more information about themselves than was previously possible. This phenomenon is referred to as self-tracking, which uses various technologies to automatically track and collect personal information in numbers. Starting in the early 2000s, self-tracking became an increasingly common practice in the life of many people. Indeed, I recall that my mobile phone (Motorola Droid Pro XT610) included a GPS, an accelerometer, and incorporated navigation software in June 2012. (Ex. 1011.) Further, being an Android operating system phone, it was relatively easy with a low barrier to

develop software for such platforms at the time. This goes to further show that mobile sensing platforms suitable for athletic monitoring were well known and readily available at the time of the earliest priority date of the '930 patent. Note that other common means of tracking were also readily available at the time, including those integrated into specialized facilities as noted below.

26. To enable self-tracking, wearable sensors were introduced into the market and used for monitoring physical or athletic activity. The monitoring of athletic activity has a number of different purposes. These include the assessment of heart rate, pulse rate, blood pressure data, body temperature, caloric energy expended, number of steps taken, as well as gait and balance. Wearable sensors can also collect speed and distance data, altitude data, and GPS data, among a variety of other parameters. At the time of the invention, wearable health monitors had a place in both monitoring athletic activity of healthy individuals, as well as for monitoring activity of sick, disabled, or otherwise impaired individuals.

27. A detailed summary of wearable sensors at around the time of the invention was published as “Wearable Systems for Monitoring Mobility-Related Activities in Chronic Disease: A Systematic Review” in the MDPI Sensors journal in October 2010. (Ex. 1012.) This review shows that there was a plethora of wearable sensing devices available at the time of the '930 patent as shown in Table 2 below. (*Id.* at Table 2.)

**Table 2.** Body fixed sensors with their properties and applications.

| <i>Device type</i>                                                                                                                                           | <i>Outcome Measure(s)/Placement</i>                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| <b><i>Pedometers</i></b>                                                                                                                                     |                                                                         |
| Yamax Digi-walker Modell SW-200 [26,29,34,36,49,50],<br>SW 700 [41], ML AW-320 [40], (Yamax, Tokyo, Japan),<br>SW 701 [38] (New Lifestyles, Kansas City, MI) | Step counts, distance, Energy<br>Expenditure/Waist                      |
| Sportline Distance Pedometer Model 342<br>(Sportline, Campbell CA) [28]                                                                                      | Distance/Waist                                                          |
| Pedometer (Seiko, Tokyo, Japan)<br>(no further specifications) [27]                                                                                          | Step Counts/Waist                                                       |
| Accusplit Eagle 170 (Pleasanton, CA) [48]                                                                                                                    | Step counts, distance, Energy<br>Expenditure/Waist                      |
| NL-800 (New Lifestyles, USA)                                                                                                                                 | Step Counts/Waist                                                       |
| <b><i>Uniaxial Accelerometers</i></b>                                                                                                                        |                                                                         |
| Z80/32KV1 activity monitor<br>(Gaehwiler Electronics; Hombrechtikon, Switzerland) [30]                                                                       | Activity counts/Waist                                                   |
| Caltrac Accelerometer<br>(Muscle Dynamics, Torrance, CA, USA)                                                                                                | Energy Expenditure/Waist                                                |
| MIT Accelerometer Modell 7164<br>(MIT, Shalimar, Florida, USA) [33]                                                                                          | Activity counts/Ankle                                                   |
| Computer Science and Applications (CSA) uniaxial<br>Accelerometer, (Computer Science and Applications, Shalimar,<br>Florida, USA) [44,45,47]                 | Activity counts/Waist                                                   |
| <b><i>Multiaxial Accelerometers</i></b>                                                                                                                      |                                                                         |
| Step Activity Monitor (SAM) (Prosthetic Research Study, Seattle,<br>WA, USA)/StepWatch Activity Monitor<br>(OrthoCare Innovations, Washington DC) [48,63]    | Step counts, step rate/Ankle                                            |
| RT3 Accelerometer<br>(Stayhealthy Inc, Monrovia, CA, USA) [31,37]                                                                                            | Activity counts, vector magnitude,<br>energy expenditure/Waist          |
| ActiGraph model GT1M (ActiGraph LLC, Pensacola, FL,<br>USA)[43]; Manufacturing Technology, Fort Walton Beach, FL) [35]                                       | Step counts, activity counts, energy<br>expenditure/Wrist, waist, ankle |
| Tritrac-R3D (Hemokinetics, Madison, WI, USA)[26]                                                                                                             | Activity counts, vector magnitude,<br>energy expenditure/Waist          |

28. The purpose of showing this table is to demonstrate the substantial availability of wearable health and fitness monitors at the time of the '930 patent. There are a number of types of monitors (e.g., Pedometers, Uniaxial

Accelerometers, and Multiaxial Accelerometers), and they measure a variety of parameters (e.g., step count, step rate, distance, energy expenditure, and activity counts). (*Id.*) A number of studies relied on the wearable sensors to have their data downloaded for processing and generation of metrics or other assessments. (*Id.* at 9039-40.) Many of the presented studies in the review paper make reference to monitoring the amount of user activity daily for multiple consecutive days. (*Id.* at 9039-42.) Several have primary metrics related to assessing user physical activity. (*Id.*) In some cases, the study looked at using the wearable devices and associated data and goals as motivators for the users. (*Id.* at 9037.) One such example states, “The review concluded that goal setting combined with feedback from a pedometer and counselling are the likely factors that explain increases in physical activity. There is, thus, increasing evidence that the definition of a step goal may be the key motivational factor in increasing physical activity []. Together the results of these studies suggest that daily walking activity is likely to improve only when a realistic step goal is defined.” (*Id.* at 9044.) Therefore, wearable activity monitors intended to provide motivation to individuals based on their level of fitness-related activity relative to goals over consecutive time intervals were well known at the time of the ’930 patent.

29. A lot of technologies for athletic activity monitoring became readily available in the last two decades. An example showing capabilities in an academic

setting entitled “Personal Digital Exercise Trainer for Managing, Monitoring and Recording the Exercise” was presented at the IEEE Engineering in Medicine and Biology Conference in 2005, and subsequently published in the associated publicly available proceedings. (Ex. 1013.) The authors describe the contribution as:

“a portable digital exercise trainer device which manages, monitors and records the user’s physical status and workout during exercise session. It guides the user in doing efficient exercise to reach specific fitness goals. It keeps the full exercise program i.e., exercises start date and time, duration, mode, control parameter, intensity in its memory which helps the user in managing his exercise. Exercise program can be downloaded from the internet. During exercise it continuously monitors the user’s physiological parameters: heart rate, number of steps walked, and energy consumed. If these parameters do not range within prescribed target zone, the device will alarm the user as a feedback to control exercise. The device displays these parameters on graphic LCD. During exercise it continuously records the heart rate and number of steps walked every 10 seconds along with exercise date and time.” (*Id.* at Abstract.)

30. This manuscript shows that about seven years prior to the earliest priority date of the ’930 patent, complex wearable exercise monitoring systems were available, they had the ability to set goals and monitor progress toward them, they had displays for showing sensor data and progress to the user, they were able to receive data to store a history, and that they were intended to be a motivating factor for athletic activity.

31. A variety of fitness trackers and smartwatches have been released on the consumer market since the early 2000s. These devices are equipped with different sensors, algorithms, and accompanying mobile apps. With mobile sensor

technology, privately collected physical activity data is used in addition to existing methods for health data collection in research. Furthermore, data collected from these devices have possible applications in personal wellness and fitness monitoring.

32. An example of such a system on the market from before the priority date of the '930 patent is the “Nike + iPod.” (Ex. 1014.) This product is representative of technologies that were well known and readily available at the time. The manual for this device from 2009, prior to the earliest priority date of the '930 patent, introduces the “personal workout assistant” as:

“Nike + iPod is a workout partner and coach all in one. Select the type of workout you want—open-ended, distance, time, or calorie-burning—choose music to keep you motivated, and then keep track of your progress every step of the way with spoken and onscreen feedback. Upload your workout data to nikeplus.com, where you can set goals and monitor your improvement from workout to workout. Join the world’s largest online running community, participating in challenges with runners from across the globe.” (Ex. 1015 at 5)

33. As noted in the above excerpt, this product allows the user to “[s]elect the type of workout,” with examples, including: open-ended, distance, time, and calorie-burning. (*Id.*) The user can “keep track of your progress every step of the way,” and do so “with spoken and onscreen feedback.” (*Id.*) The user is able to “[u]pload your workout data” to a website. (*Id.*) From the website, the user can “set goals.” (*Id.*) And, further from the website, the user can “monitor your improvement from workout to workout.” (*Id.*) This product receives data at either

an iPod or iPhone from a sensor. For the case of an iPod such as the nano, the user is to “[a]ttach the Nike + iPod receiver to iPod nano,” and for the case of an iPhone or iPod touch, those devices “have an internal receiver; no externally attached receiver is required.” (*Id.* at 6.)

34. One example of a sensor that transmits data received by the iPod or iPhone is intended to go in a shoe such that the user is instructed to “[i]nser[t] the Nike + iPod Sensor in your Nike+ ready shoe.” (*Id.* at 7.) Another example is a pulse rate sensor, wherein the user can “link to a Nike+ compatible heart rate monitor.” (*Id.* at 20.) The user may then choose a type of workout, with examples provided being: “[a] workout with a time goal,” “[a] workout with a distance goal,” and “[a] workout with a calorie burning goal.” (*Id.* at 8.) While exercising, the system “automatically displays your workout status on the screen.” (*Id.* at 9.) The manual goes on to say that “[y]ou can end your workout at any time. If you continue working out after you reach your time, distance, or calorie goal, your progress continues to be monitored” (*Id.* at 10), which indicates that the user can readily monitor if/when they meet and exceed a goal. Further, from a website the user can “track your progress over time, view a record of all of your past workouts, set and monitor goals” (*Id.*), which shows that previous workout data and goals are stored and readily available for viewing and analysis. In fact, the manual notes

that the user's device can "save[] the date, time, duration, distance, pace, and calories burned for up to your last one-thousand workouts." (*Id.* at 17.)

35. Athletic movement monitoring is not only restricted to self-monitoring. In fact, the challenged patent specifically identifies use cases of motion capture systems such as infrared cameras tracking body parts, which are typically integrated into specialized facilities. Measuring and analyzing body motion using such systems was commonplace at the time of the invention. And, in fact, there are numerous examples of such sensing systems being used to monitor users as they are instructed to perform various physical activities so as to provide quantitative metrics. In research efforts related to rehabilitation and wearable assistive devices and exoskeletons, there are many such high-profile, well-known published works. One such example was published by Sawicki *et al.* in 2008, entitled "Mechanics and Energetics of Level Walking with Powered Ankle Exoskeletons." (Ex. 1016.) This study measured the motion of a user on a specialized treadmill while also measuring muscle activity using EMG, metabolic activity through O<sub>2</sub> and CO<sub>2</sub> sensing, force sensing, and motion capture. Various measures were generated from the data including joint range of motion (e.g., range of ankle angle motion) which can be related to flexibility. And other measures such as power are assessed which can be related to athleticism. Multiple tests are performed over multiple sessions and individual and combinatory scores are

generated. Other similar works from this investigator and others demonstrated that such assessment techniques were common at the time of the invention.

36. In the arena of personal wellness, there has long been a prevailing attitude that while people generally understand that being physically active is important for leading a healthy lifestyle; finding motivation to engage regularly in exercise can be challenging. Indeed, a variety of studies document the existence of various barriers to exercise motivation. (Ex. 1012 at 9038, 9043-44.) For example, one reason people may fail to regularly engage in a workout regimen is that exercises may be unfamiliar. While an individual may want to gain muscle, tone, or lose weight in certain areas, learning new exercises may take time and heighten the barrier to exercise. Additionally, people often become comfortable in their daily routine, which may be more sedentary in nature. Studies show that without a reminder or obvious cue (e.g., direct feedback), people may not be aware of their physical activity for the day or otherwise be prompted to increase their level. (*Id.* at 9031-32, 9044.) Importantly, negative consequences for failing to engage in exercise are not typically immediate. For example, if an individual elects not to exercise on a given day, the short-term impact is often negligible though the long-term consequences remain, such as weight gain, heart disease, cancer, and diabetes. Studies show, however, that the possibility of a primarily

long-term health benefit is often not enough as a sole motivator to prompt individuals to adopt a daily regimen. (*Id.* at 9038.)

37. The fitness industry has long been familiar with various factors that contribute to overall barriers to regular exercise. Indeed, understanding these factors prompted several areas of focus that became widely implemented. The first of these was setting a goal for a workout. Having a defined goal of exercising for a period of time (*e.g.*, 30 minutes) and/or performing a particular exercise both encourages a user to engage in activity for a finite period as well as demystifies potentially new and unfamiliar exercises. (*Id.*) Secondly, developing an awareness of physical activity on a regular basis relative to the established goal is necessary. The more an individual understands about their physiological status (*e.g.*, pulse and heart rate), the more an individual is able to cultivate an awareness of their progress over time as well as towards a particular goal. (*Id.* at 9043.) An individual is often more motivated by trying to improve upon their own “personal best” and aspire to more frequent and higher intensity goals by tracking their physiological status over time. Finally, to counteract the lack of immediate short-term gain, fitness programs have developed rewards and incentives tied to an individual’s compliance with an exercise regimen. The more an individual exercises, the greater the reward. The existence of positive reinforcement models has long been key to motivating a user to engage in regular exercise, as well as

exceed specific activity goals in exchange for more enticing rewards. Rewards often take the form of tangible or intangible prizes that are specifically intended to encourage the individual to reach greater heights of physical activity. This way, the individual stays motivated while also developing a healthier lifestyle through regular physical activity over time.

## **B. Overview of the '930 Patent**

38. The '930 patent relates to “monitoring a user performing an athletic movement and/or exercise and generating a combinatory fitness athleticism score.” (Ex. 1001, Abstract.) The specification describes “systems and methods for estimating a combined or a combinatory fitness-athleticism score,” both of which may be comprised of a fitness sub-score and an athleticism sub-score. (*Id.* at 1:49-51.) According to the '930 patent, the fitness-athleticism score may be “estimated based on a user’s athletic movements, wherein the user’s athletic movements are monitored by a first sensor.” (*Id.* at 1:52-54.) The '930 patent describes “athletic movement” as “movements relating to fitness, exercise, flexibility, including movements that may be part of one or more single and multiple participant athletic competitions, exercise routines, and/or combinations thereof.” (*Id.* at 4:7-11.)

39. The '930 patent discloses that a sensor may be “worn around an appendage of the user” and “configured to capture data related to the movement of

the appendage of the user.” (*Id.* at 1:56-59.) Exemplary sensors include “an accelerometer, a gyroscope, a location-determining device (e.g., GPS), light sensor, temperature sensor (including ambient temperature and/or body temperature), sleep pattern sensors, heart rate monitor, image-capturing sensor, moisture sensor and/or combinations thereof.” (*Id.* at 5:36-41.) The ’930 patent also teaches that a user may “possess, carry, and/or wear any number of electronic devices, including sensory devices . . . .” (*Id.* at 6:7-8.) These portable electronic devices may include non-fitness devices to “collect, detect, and/or measure athletic data,” such as the Apple IPOD®, IPAD®, or iPhone®. (*Id.* at 6:11-17.) Such devices may contain one or more sensors or wirelessly communicate with other wearable sensors. (*Id.* at 6:27-43.) Exemplary wearable sensors according to the ’930 patent are associated with a user’s clothing or accessories, such as a “watch, armband, wristband, necklace, shirt, shoe, or the like.” (*Id.* at 7:18-19.)

40. According to the ’930 patent, a user may be instructed to perform an athletic movement with predefined criteria. (*Id.* at 12:55-57.) Instructions may be “audible, visual, tactile or combinations thereof” and may involve “demonstrating proper form for an exercise and prompting the user to perform the exercise . . . .” (*Id.* at 22:60-65.) A display device may also “present a virtual trainer demonstrating an exercise to instruct the user on proper form . . . .” (*Id.* at 23:3-7.) The specification further describes prompting a user user to perform a plurality of

exercise drills in a single workout session. (*Id.* at 23:24-25.) The '930 patent discloses that upon receipt of instructions, one or more sensors may monitor the user's physical movement and a processor subsequently executes computer-executable instructions to "receive movement data captured by the sensor, and/or to estimate a combined fitness-athleticism score from the received movement data." (*Id.* at 1:61-66.)

41. As shown in Figure 12 below, the combined or combinatory fitness-athleticism score, e.g., "76/65," may be shown on a display device to the user wherein "76" represents the user's fitness sub-score and "65" represents an athleticism sub-score. (*Id.* at 22:31-34.) The combinatory score may also be represented by a single score wherein the athleticism sub-score and the athleticism sub-score are averaged, summed, or otherwise combined. (*Id.* at 22:38-41.) The '930 patent teaches that fitness sub-scores, athleticism sub-scores, and the combinatory score may "consider a plurality of parameters relating to the user's performance." (*Id.* at 23:7-9.) Exemplary parameters include a user's form, tempo, estimated fatigue, and oxygen kinetics. (*Id.* at 23:9-11.)

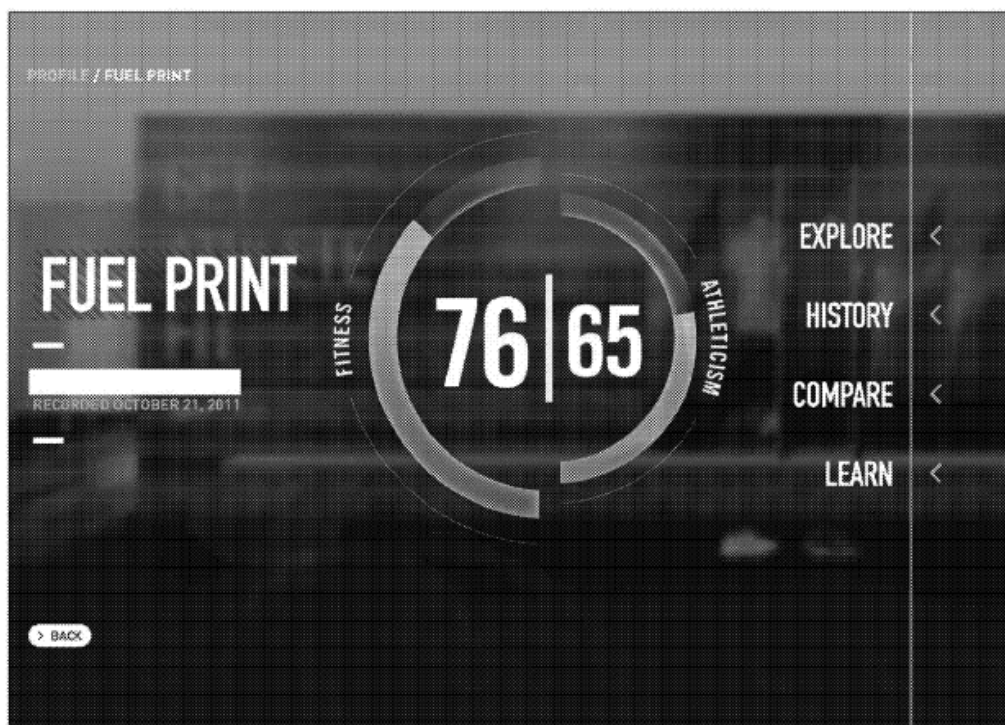


FIGURE 12

(Ex. 1001 at Fig. 12.)

42. The '930 patent further discloses that the combinatory score and/or the sub-scores may be calculated by “combining a plurality of drill scores,” which may be “summed, averaged or otherwise utilized . . . .” (*Id.* at 24:63-66.) Such drills may be presented in a predefined ordering or vary among different workout sessions. (*Id.* at 24:18-21.) A plurality of drills in a single workout session “may be designed to specifically test attributes of athleticism” and “specifically test attributes of fitness.” (*Id.* at 23:27-31.) Exemplary fitness attributes include “endurance, flexibility, strength and combinations thereof,” while exemplary athleticism attributes include “speed, agility, reaction, power, balance, and combinations thereof.” (*Id.* at 23:36-41.) In order to determine sub-scores and a

combinatory score, “[o]ne or more attribute values may be detected, measured, and/or calculated . . . .” (*Id.* at 23:33-35.) According to the ’930 patent, “a single exercise may be utilized to measure at least one athleticism attribute and at least one fitness attribute.” (*Id.* at 23:31-33.)

43. The ’930 patent finally describes how various exemplary fitness and athleticism attributes may be measured. For example, an endurance fitness attribute may be “determined from drills comprising or consisting of vertical jumps” based on “the quantity of vertical jumps the user conducts within a predetermined time period . . . .” (*Id.* at 23:48-51.) A flexibility fitness attribute may be “determined from reps of leg raises and/or reverse reaches.” (*Id.* at 23:52-53.) A strength fitness attribute may be calculated by evaluating a user’s “performance of reps of static lunges and/or push-ups” or “ability to maintain their performance within a predetermined range of tempo during the activities . . . .” (*Id.* at 23:55-59.) A power athleticism attribute may be “determined from drills comprising or consisting of vertical jump” by measuring the vertical distance the user achieves achieved. (*Id.* at 23:60-66.) A balance athleticism attribute may be calculated based on “hop and sticks” drills wherein a user’s stability may be measured. (*Id.* at 23:66-24:1.) Finally, speed, agility, and reaction athleticism attributes may be determined from “drills comprising or consisting of cone sprints” by measuring an user’s “reaction and/or target return . . . .” (*Id.* at 24:1-5.)

## **VI. Level of Skill in the Art**

44. A POSITA for the technology of the '930 patent would have had (1) a bachelor's degree in engineering, computer science, industrial design, biomechanics, or a related field, and (2) at least two years of experience researching, developing, designing, and/or testing fitness or physiological sensors, wearable devices, physiological or biomechanical devices, remotely-controlled systems or interfaces, and/or network-based applications and/or equipment, or the equivalent experience or education.

## **VII. Claim Construction**

45. For all other terms, if any, I have been instructed to perform my analysis with the understanding that the terms of the Challenged Claims should be afforded their plain and ordinary meaning. However, should Patent Owner and/or Patent Owner's expert choose to construe additional claim terms or challenge the ones herein, I reserve the right to provide my opinion regarding Patent Owner's construction(s), as well as the meaning of a POSITA would have ascribed to those claim terms.

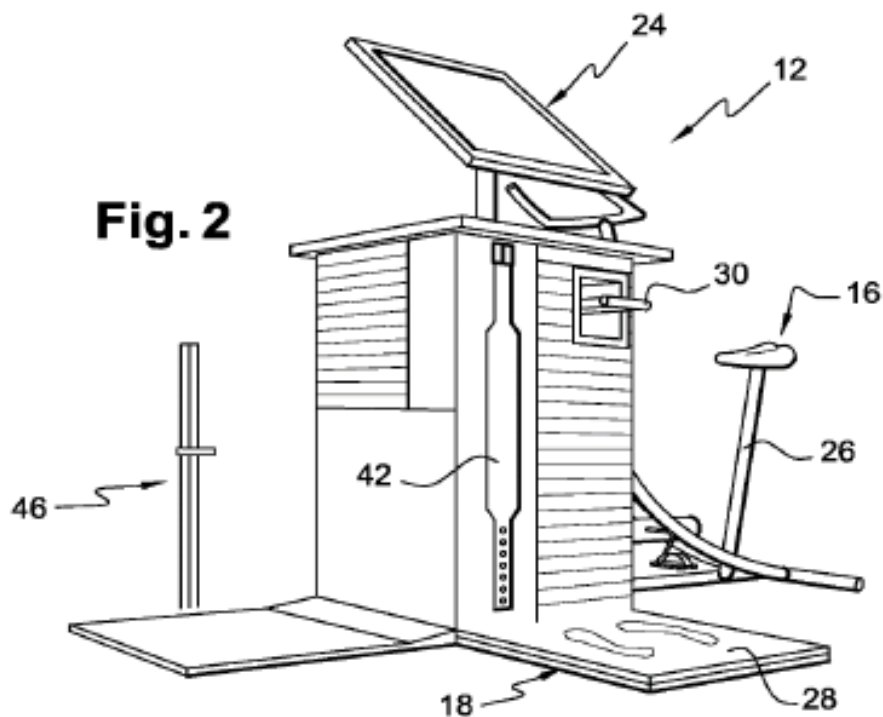
## **VIII. The Prior Art**

46. The challenged claims can be categorized into two primary groups: method claims 1-5 and 7; and computer readable medium claim 11.

## **A. Overview of Lofi**

47. Lofi (Ex. 1002) was published on October 26, 2006. Thus, Lofi qualifies as prior art based on my understanding that the '930 patent's earliest possible priority date of June 4, 2012.

48. Lofi discloses a “device for evaluation of a person’s physical fitness.” (Ex. 1002 at 1:1.) It notes that various tests may be used to evaluate “physical characteristics of a person, for example endurance, flexibility...” (*Id.* at 1:2-3.) In Figure 2, reproduced below, Lofi describes a “measurement terminal of physical fitness parameters.” (*Id.* at 3:5-6.) The terminal device is described as: “The terminal 12 includes means 14 of data input, means 16 of measurement of endurance, means 18 of measurement of body composition, means 20 of measurement of muscular strength, and means 22 of measurement of at least one characteristic relating to coordination or motricity.” (*Id.* at 3:23-26.) The device is intended to “make it possible for a person to evaluate their physical fitness autonomously and reliably.” (*Id.* at 2:10-12.) Lofi’s terminal device thus receives measurement data from the sensors corresponding to the physical activity for each test.



(Ex. 1002 at Fig. 2.)

49. Lofi describes a variety of tests to evaluate a user's fitness based on: "means of measurement of endurance," "means of measurement of body composition," "means of measurement of muscular strength," and "means of measurement of at least one characteristic relating to coordination or motricity." (*Id.* at 2:15-19 (emphasis added).) It should be noted that the term "fitness," as used by Lofi, is a broader term encompassing at least the attributes noted above, this is not the same as the specific narrow use of "fitness" in the "fitness sub-score" of the challenged patent. Specifically, the "endurance" and "strength" assessments of Lofi would be classified at least as fitness-related sub-scores, and "coordination or motricity," which is related to "balance" and "reaction," would be classified at

least as athleticism-related sub-scores according to the claims of the '930 patent. However, in some cases the measurements used to assess these tests provide additional information—for example Lofi describes measuring “a signal proportionate to a measurement indicated as a result of the endurance means, in Watts, corresponding to the maximum oxygen consumption” as part of assessing endurance. (*Id.* at 4:21-22). Watts are a measure of power; thus a POSITA would understand that this assessment also can provide an assessment of power, which is classified as an athleticism-related sub-score in the '930 patent.

50. Lofi provides the following example means for assessing strength of lower limbs using the integrated ergometric bicycle: “the person is asked to pedal as fast as possible for a short period of approximately 10 seconds. During this period of time, the means to control rapidly increase load on the pedaling. Given that the resistance is increasingly greater, the speed of pedaling decreases after a few seconds. The peak of the strength/speed curve corresponds to the maximum capacity of legs expressed in Watts.” (*Id.* at 5:12-18). Thus, this is an example of a single test or activity that assesses both strength and power, which correspond to athleticism and fitness, respectively (according to the claims of the '930 patent). Lofi also describes means for assessing strength upper limbs, abdominal muscles, and grip strength. In some embodiments, sensors may be worn in an abdominal belt while in other embodiments sensors may be located in the device.

51. Lofi also describes “The means [] of measurement of at least one characteristic relating to the coordination or motricity preferably include, means to measure the reflexes of the person, means to measure their flexibility and means to measure their balance.” (Ex. 1002 at 7:10-12 (emphasis added).). Thus, this is yet another example of a single test or activity that assesses both athleticism and fitness, since measurements of reaction (*i.e.*, reflexes) and balance both correspond to athleticism and flexibility corresponds to fitness (according to the claims of the ’930 patent).

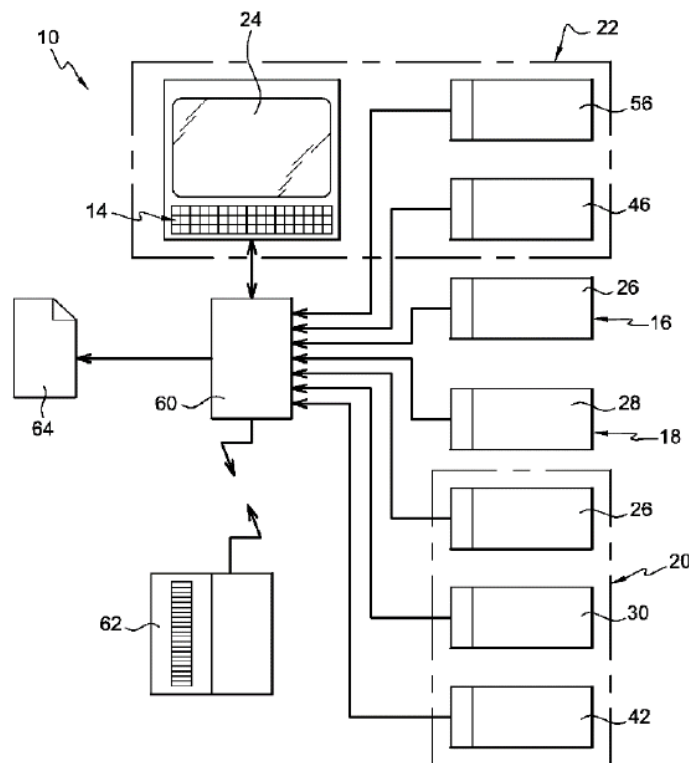
52. The system of Lofi provides just-in-time instructions as needed for the user to carry out the activities. For example, in a test for reflexes “the person is asked to press a button or touch screen 24 if they hear or see a signal. The transmission of visual or audible signals is managed by the means of control which also measure the reaction times of the person corresponding to the period between transmission of the signal and the action generated by the person in response.” (*Id.* at 7:13-18.) Obviously, these instructions are provided during the time period in which the activity is being completed as it would be impossible to assess reaction time otherwise. More generally, Lofi describes providing instructions to users during the course of them performing the instructed activities. And Lofi further describes processing the scores from the various tests, comparing measurements to the population, and creating combined scores that can be displayed for the user on

the terminal. Lofi notes that “means of return display the overall score of physical fitness together with scores for each measure.” (*Id.* at 11:21-22.)

## 1. Lofi’s Disclosure Mirrors the Challenged Claims

### a) Claim 1 – A computer-implemented method comprising:

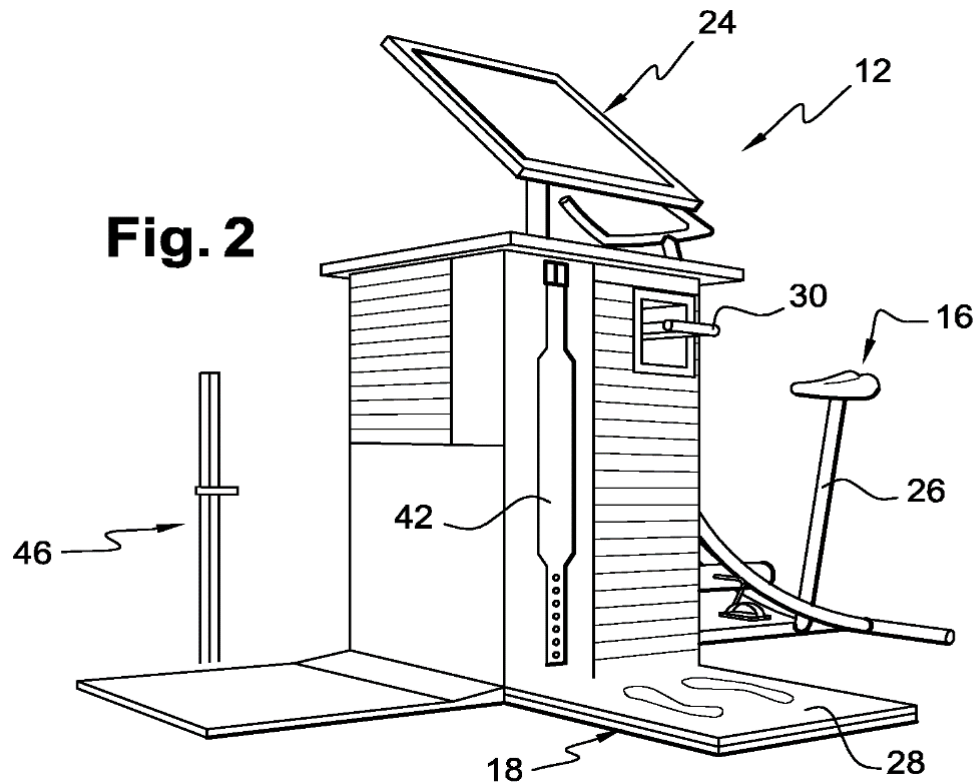
53. Lofi teaches a computer-implemented method. Figure 1 of Lofi, reproduced below, shows a diagram representing the device of the invention. The terminal of Lofi comprises a computing system and includes “means 14 of data input include a screen 24 and/or keyboard.” (Ex. 1002 at 3:27.) Further, Lofi incorporates a “means of processing to determine for each measurement a score . . . .” (*Id.* at 2:24.)



(*Id.* at Fig. 1)

**(i) providing first instructions to a user to perform a first athletic movement;**

54. Lofi describes “providing first instructions to a user to perform a first athletic movement.” There are a number of examples of such in the disclosure, that take advantage of the various pieces of equipment integrated into the terminal as shown in Figure 2, reproduced below. One such example task is related to an assessment of endurance: “The means 16 for measurement of endurance it possible to evaluate the fitness of a person by sustained effort. According to a method of calculation, a 26 ergometric bicycle is used for this purpose.” (*Id.* at 4:4-6.) In this task, the user is instructed to perform a specific cycling action: “According to an example test, to achieve the measurement, the person is asked to pedal for a period of 8 minutes and the workload is increased progressively.” (*Id.* at 4:7-8.) For this endurance cycling task, pedaling is the “first athletic movement,” and the instruction from the device telling the user to “pedal for a period of 8 minutes” is clearly the corresponding “first instruction” corresponding to that task.



(*Id.* at Fig. 2)

55. In a further cycling task, strength can be assessed: “the 26 ergometric bicycle can be used to measure the leg strength.” (*Id.* at 5:12.) In this task, the user is instructed to perform a different cycling action: “According to an operating procedure, the person is asked to pedal as fast as possible for a short period of approximately 10 seconds.” (*Id.* at 5:13-14.) For this strength cycling task, pedaling at a user’s highest speed is the “first athletic movement,” and the instruction from the device telling the user to “pedal as fast as possible for a short period of approximately 10 seconds” is clearly the corresponding “first instruction” corresponding to that task.

56. Another example strength test is disclosed by Lofi as: “To measure the quality of the abdominal muscles, an abdominal belt 42 is used.” (*Id.* at 6:24.) The sensor-integrated belt is shown in Figure 1 above, and in more detail in Figure 6, reproduced below. To perform the task, Lofi describes: “In line with an operating procedure, the person is asked to position a belt at waist level. When the belt is in place without contraction of the abdominal muscles, the belt transmits a signal corresponding as originally. The person is then asked to contract their abdominal muscles voluntarily.” (*Id.* at 7:2-5.) For this strength task, contracting the abdominal muscles on command is clearly the “first athletic movement” happening at the time the “first instruction” is provided. Of note, Lofi clearly notes that this instruction happens during the task right at the time when the action is expected to happen (after being asked to don and position the belt and before they perform the muscle contraction).

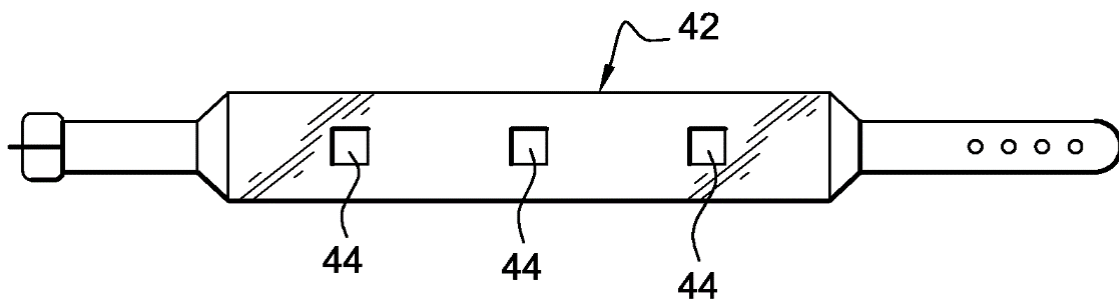
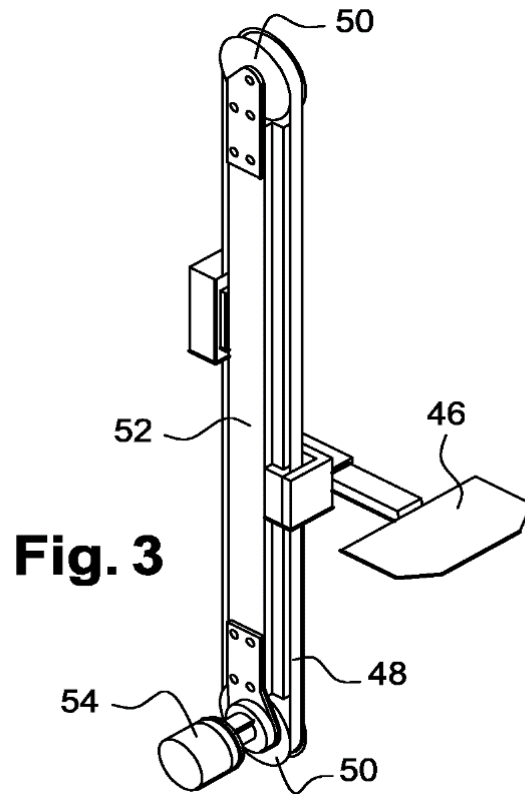


**Fig. 6**

(*Id.* at Fig. 6)

57. Lofi describes another example test which is intended to assess flexibility: “To measure the flexibility of the person, a portable pallet 46, illustrated in Figure 3, can be used. The portable pallet 46 is connected to a belt 48, stretched between two pulleys 50 positioned at the extremities of a vertical post 52.” (*Id.* at 7:20-23.) The corresponding device for this flexibility test is shown above in Figure 1, and in more detail in Figure 3, reproduced below. And, again the user is provided an instruction corresponding to the required action at the time they are expected to perform the action: “the person is asked to stand on a heightened pedestal, and bring the pallet to as low as possible, bending forwards without giving way to their legs.” (*Id.* at 8:1-2.)



(*Id.* at Fig. 3)

58. Lofi also describes a reaction test. This test “measure[s] the reaction times of the person [and] correspond[s] to the period between transmission of the signal and the action generated by the person in response.” (*Id.* at 7:16-18.) In a specific reflex test designed to assess reaction time, a person is asked to press a button or touch a screen if they hear or see a signal. (*Id.* at 7:13-14.) The reaction test “measures the reaction times of the person [and] correspond[s] to the period between transmission of the signal and the action generated by the person in response.” (*Id.* at 7:16-18.)

59. A further test is described by Lofi with regard to assessing balance: “[t]o measure the balance, the preference is to use a statokinesimeter 56 . . . .” (*Id.* at 8:8.) Such an apparatus is intended to measure the user’s center of gravity and is shown above in Figure 1, and in more detail in Figure 5, reproduced below. As with the previous examples, the user is provided detailed instructions as they perform the task. In this case there are three parts to the test: “According to an operating procedure, the person is asked to stand on the scales and undergo three tests, the first supported on both feet with their eyes open, the second supported on both feet with eyes closed and the third supported on one foot.” (*Id.* at 8:25-28.) As can be seen from each of the above examples, Lofi clearly describes “providing first instructions to a user to perform a first athletic movement”.

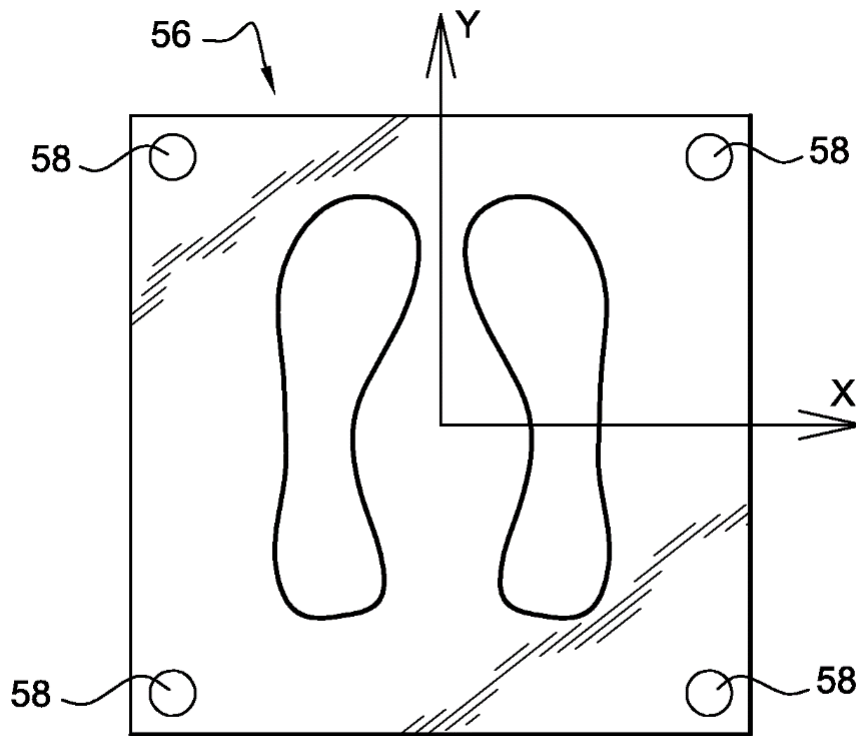


**Fig. 5**

(*Id.* at Fig. 5)

- (ii) **receiving, from a sensor, first activity data representing the first athletic movement;**

60. The apparatus of the device in Lofi is integrated with a variety of sensors. The sensors are intended to collect “first activity data” corresponding to the “first athletic movement.” For the first example noted related to endurance while cycling, Lofi discloses “The cardiac rhythm is measured for several seconds at each step, and the increased workload for each step adjusted to ensure that the heartbeat approaches 80% of the theoretical maximum heart rate.” (*Id.* at 4:10-13.)

In this case a heart rate sensor provides one example of sensor data related to the corresponding athletic movement (*i.e.*, “pedal for a period of 8 minutes”). With regard to the strength cycling example, Lofi describes that during the activity period “the means to control rapidly increase load on the pedalling. Given that the resistance is increasingly greater, the speed of pedalling decreases after a few seconds. The peak of the strength/speed curve corresponds to the maximum capacity of legs expressed in Watts.” (*Id.* at 5:14-18.) Thus, the apparatus is designed to sense the activity data necessary for generating the “strength/speed curve.”

61. In the above example related to abdominal strength, Lofi describes the use of a sensorized belt as shown above in Figure 6. The belt is described as “The belt contains one or more pressure sensors 44 or strain gauges which can measure the action of abdominal muscles on the belt.” (*Id.* at 6:24-7:1.) This clearly describes an apparatus for the activity comprising sensors intended to assess the activity. More specifically: “When the belt is in place without contraction of the abdominal muscles, the belt transmits a signal corresponding as originally. The person is then asked to contract their abdominal muscles voluntarily. The belt then transmits a signal proportionate to the effort exerted by the abdominal muscles on belt 42.” (*Id.* at 7:3-6.) This statement demonstrates that Lofi clearly teaches a sensor that generates a signal related to the first activity (*i.e.*, activity data), that

this signal is transmitted to the terminal, and that is corresponds specifically to the requested user activity.

**(iii) calculating with a processor, based on the first activity data, a first combinatory fitness-athleticism score;**

62. Lofi describes a terminal for evaluating a user's physical fitness as shown in Figure 2. The terminal device is described as: "The terminal 12 includes means 14 of data input, means 16 of measurement of endurance, means 18 of measurement of body composition, means 20 of measurement of muscular strength, and means 22 of measurement of at least one characteristic relating to coordination or motricity." (*Id.* at 3:23-26.) The terminal incorporates a "means of processing to determine for each measurement a score based on comparison of the measured value with the distribution curve corresponding to the person's population group." (*Id.* at 2:23-25 (emphasis added).) Further, Lofi describes that device includes: "means of measurement and data input, means of control to manage all parts, means for the processing of measures and means for returning results." (*Id.* at 3:17-20 (emphasis added).) Thus, the terminal, whose schematic is shown in Figure 1, clearly represents a processor, and that processor generates a result (*i.e.*, scores) based, at least in part, on the data coming from the sensor measurements. As previously noted, Lofi clearly describes collecting said activity

data from sensors during the corresponding activities. Lofi also describes generating a result, or score, utilizing that data.

63. Lofi notes that “for each measurement, the means of processing determine a score comparing the measured value with the distribution curve corresponding to the person’s population group.” (*Id.* at 10:7-9.) This statement clearly shows that Lofi describes generating a score from the acquired data from fitness tests. As previously described, the fitness tests of Lofi are designed to assess one or measures of “fitness” or “athleticism” as defined by the claims of the ’930 patent. One or more such tests could be utilized to generate scores corresponding individually to “fitness” and “athleticism.” While the ’930 patent notes that a combinatory score could be simply showing the two scores together as shown in Figure 12 of the ’930 patent above, Lofi further describes an example of generating an aggregate combined score as “The score corresponding to physical fitness is equivalent to the average scores with a coefficient 1 for the measurement of body composition, a coefficient 1 for measurement of endurance, a coefficient 1 for measurement of the muscular strength (1/3 for measurement of the strength of upper limbs, 1/3 for measurement of the strength of lower limbs and 1/3 for measurement of abdominal strength) and a coefficient 1 for measurement relating to motricity (1/3 for the measurement of reflexes, 1/3 for measurement of flexibility and 1/3 for measurement of balance).” (*Id.* at 10:17-23.)

64. In an example activity of Lofi, the user is assessed of both “Strength” and “Power,” thus both “fitness” and “athleticism” (as defined in the claims of the ’930 patent), respectively. The challenged patent describes a fitness-related sub-score as “one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user,” and an athleticism-related sub-score as “one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute, and a balance athleticism attribute of the user.” (Ex. 1001 at Claim 1 (emphasis added).) In the cycling example describe above, Lofi notes that “means 16 of measurement of endurance transmits to the processing means a signal proportionate to a measurement indicated as a result of the endurance means, in Watts . . . .” (Ex. 1002 at 4:20-22). As clearly stated, the device uses this measurement to assess endurance after being processed, a fitness-related sub-score as identified by the ’930 patent. Further, the sensor measures and reports sensor data in Watts. A Watt is a unit of power, thus the device of Lofi simultaneously is assessing mechanical power exerted by the user and using that data over the time period (*i.e.*, energy expenditure) to generate a measure of endurance. A POSITA would understand that this corresponds to two unique measurements generated by the device for a single activity corresponding to endurance (*i.e.*, fitness sub-score) and power (*i.e.*, athleticism sub-score). Should Patent Owner contend that the

measured power in Watts is only an internal measure used by the processor, it most certainly would have been obvious (and of interest to the user) to present to them the power exerted. And, since that data is already in the terminal, it would have been trivial to display it. Figure 12 of the '930 patent shows an example of the “combinatory fitness-athleticism score.”

65. The '930 patent makes it clear that it is NOT necessary to generate a single combined number or score, and that “In certain embodiments, the combinatory score may be represented by the two individual sub-scores, such as shown in FIG. 12 . . . .” (Ex. 1001 at 22:34-36 (emphasis added).) Thus, simply reporting a value corresponding to the power and a value corresponding to the endurance of the example activity satisfies a “combinatory fitness-athleticism score.” When this corresponds to the first activity, and the data comes from that first activity, then it is clearly “a first combinatory fitness-athleticism score.” Further, should a single value for the combinatory score be desired, the '930 patent does not require a complex approach to calculating a single score—it notes that “In one embodiment, a plurality of sub-scores, such as including the athleticism sub-score and the athleticism sub-score may average, summed, or otherwise combined to form a single score.” (*Id.* at 22:38-41.) Thus, it would have been obvious and trivial to a POSITA to combine the sub-scores into a single number if so desired.

66. In another example, Lofi teaches that the various fitness tests may be administered as part of a series in a single workout session. In one embodiment, a user may complete a strength test followed by a balance test. Upon completion of the first strength tests, a user may be subsequently instructed to commence a balance test. (Ex. 1002 at 8:25-9:2). Here, a user may be provided with a first set of instructions to complete the strength test (*e.g.*, to contract abdominal muscles) and corresponding activity data related to this movement is collected. Upon completion of the strength test, a user may be subsequently instructed to commence a balance test. (*Id.*) To measure balance, Lofi discloses that “the preference is to use a statokinesimeter . . . .” (*Id.* at 8:8.) The collected measurement data is subsequently transmitted to a means for processing (*e.g.*, terminal), which receives the data for further analysis. A first combinatory score may then be issued as the result of a user completing a strength test and a balance test. An aggregate score is presented to the user as well as scores for each test. (*Id.* at 11:20-24.) The score for the strength test represents a fitness sub-score, while the score for the balance test corresponds to an athleticism sub-score.

67. Additionally, in another example activity of Lofi, the user is assessed of both “Flexibility” and “Balance,” thus both “fitness” and “athleticism” (as defined in the claims of the ’930 patent), respectively. As previously described, Lofi clearly provides examples of tests for flexibility and balance (related to the

apparatuses shown in Figures 3 and 5, respectively). A POSITA would understand that these could readily be integrated into a single activity wherein a user stands on the balance board of Figure 5, while simultaneously pushing the pallet of Figure 3. Indeed, this is essentially just an instrumented way of asking a user to perform the typical activity of trying to touch their toes while standing. So, while a POSITA would understand that one could combine multiple tests into a single “first activity,” even if Patent Owner contends that a single test of Lofi corresponds to a single activity, it would have been obvious to combine multiple tests into a single activity based on the disclosure of Lofi.

**(iv) providing, in response to a triggering event, second instructions to the user to perform a second athletic movement;**

68. The user entering a username and password on the terminal is a triggering event upon which second instructions are provided to the user. Lofi discloses that the user can repeat the fitness tests to “revise their [] results.” (*Id.* at 12:3-5.) Lofi teaches that a user can revise the result (*i.e.*, score) of a previous test by entering a username and password at a terminal and repeating the test. (*Id.* at 12:1-7.) The user entering a username and password is the triggering event while the second instructions are the same as the first instruction, thereby allowing the user to repeat the same tests and revise their results.

69. Alternatively, the completion of a fitness test serves as a triggering event. The above-described tests of Lofi would be completed in a sequential manner in a single workout session. Lofi describes the system as “This terminal makes it possible, in a reduced space, to collect these different measurements regarding a person to facilitate the evaluation of their physical fitness, autonomously and with reliability.” (Ex. 1002 at 9:18-20.) Lofi clearly describes how each test provides instructions to the user at the time of the test as previously detailed. According to Lofi, the “following tests are carried out: measurement of reflexes, measurement of the strength of upper limbs, measurement of abdominal strength, measurement of flexibility, measurement of strengths of lower limbs and measurement of endurance” wherein each stage has a “duration of approximately 15 minutes.” (*Id.* at 11:15-19.) The completion of each 15-minute fitness test in this series serves as a triggering event upon which instructions are provided to the user to perform an athletic movement associated with the next test.

70. Being an autonomous system, clearly the terminal of Lofi would provide the instructions for the first activity, and then provide the instructions for the next activity in the sequence, and continue to do so until all of the required activities are completed. In an exemplary embodiment, a user completes a strength test is provided with instructions to complete a balance test. In fact, Lofi explicitly describes the sequential workflow: “According to an operating procedure, the

person settles in front of the terminal at the right of screen 24. The person inputs their age, gender, height in order to identify the population to which they belong. Once this stage is completed, the different measurements are implemented. The person is asked to stand on weighing scales 28 in order to measure their weight, body composition and measurement of balance. Subsequently, the following tests are carried out: measurement of reflexes, measurement of the strength of upper limbs, measurement of abdominal strength, measurement of flexibility, measurement of strengths of lower limbs and measurement of endurance.” (*Id.* at 11:9-18.) Completing one activity would be the “trigger event” to begin the next activity in the sequence, and the instructions provided for that next activity correspond to the “second instructions to the user to perform a second athletic movement.”

**(v) receiving, from the sensor, second activity data representing the second athletic movement;**

71. As noted above, the apparatus of the device in Lofi is integrated with a variety of sensors. The sensors are intended to collect activity data corresponding to athletic movement. The collected measurements for a fitness test (*e.g.*, abdominal strength) represent activity data. If a user repeats their fitness tests as described above to “revise their [] results,” second activity data representing the second athletic movement will be received by the processing unit in the same way that the first activity data was received. If a user completes a

series of tests in a single workout session as described above, second activity data representing the second athletic movement (*i.e.* corresponding to the second fitness test) will be received by the processing unit in the same way that the first activity data was received (*i.e.* corresponding to the first fitness test).

**(vi) calculating, with the processor, based on the second activity data, a second combinatory fitness-athleticism score,**

72. Lofi discloses calculating a second combinatory fitness-athleticism score based on the second activity data. When a user repeats the tests to “revise their [] results,” a new combinatory fitness-athleticism score is calculated based on the second activity data received as part of the new test.

73. In another example, if a user completes a series of fitness tests in a single workout session, Lofi teaches that a user completes a strength test followed by a balance test. Completion of the strength test corresponds to the first athletic movement activity, its sensor data correspond to first activity data, and its scores correspond to the first combinatory score. Upon completion of the balance test, Lofi teaches that a means for processing calculates a result score reflecting the “average position of the center of gravity” based on the “values measured by the sensors . . . .” (*Id.* at 8:15-19.) A POSITA would understand that the balance test (*e.g.*, subsequent activity in the sequence), corresponds to the second athletic movement activity, its sensor data correspond to second activity data, and its

scores correspond to the second combinatory score in the same way as for the first activity.

- (vii) **wherein the first and the second combinatory fitness-athleticism scores each comprise a fitness sub-score and a separate athleticism sub-score of the user, wherein the fitness sub-score is calculated, by the processor, using one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user, and wherein the athleticism sub-score is calculated, by the processor, using one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute and a balance athleticism attribute of the user.**

74. The combinatory scores are the result of a user completing an endurance, strength, flexibility, balance, and reaction time tests. An aggregate score is presented to the user as well as individual scores for each test. (*Id.* at 11:20-24.) The scores for Lofi's strength, flexibility, and endurance tests each correspond to the claim's fitness sub-score while Lofi's scores for its balance and reaction time tests correspond to the claim's athleticism sub-score.

- b) **Claim 5 – The method of claim 1, wherein the first athletic movement comprises predefined criteria, the method further comprising: providing the first instructions to the user to perform, during a first time period, the first athletic movement.**

75. As described above (*See supra* VIII.A.1.a), Lofi clearly teaches providing the instructions for an activity at the time of said activity, and this during

a first time period. In one example, Lofi teaches a strength test of the lower limbs on a bicycle wherein the user is instructed to pedal as fast as possible for a short period of approximately 10 seconds while the resistance on the bicycle is increased. (*Id.* at 5:13-16.) Pedaling at a user's highest speed represents a first athletic movement of predefined criteria and 10 seconds represents a first time period.

76. In another example, Lofi clearly states a series of fitness tests are carried out as follows: “measurement of abdominal strength, measurement of flexibility, measurement of strengths of lower limbs and measurement of endurance” wherein each test has a “duration of approximately 15 minutes.” (*Id.* at 11:16-19.) By disclosing that “[t]he stages each have a duration of approximately 15 minutes,” (*Id.* at 11:19), Lofi teaches the time period corresponding to an activity. And it is very clear that Lofi presents the instructions for that activity during the corresponding time period, as it provides instructions to the user as they perform the activity. Thus, in the example above, the first athletic movement of predefined criteria may correspond to the exercises associated with the abdominal strength test (*e.g.*, contracting abdominal muscles) and 15 minutes represents a first time period. Accordingly, Lofi renders claim 5 obvious.

- c) Claim 6 – The method of claim 1, wherein the first instructions and the second instructions include a plurality of drills configured to test a plurality of fitness**

**attributes of the user and a plurality of athleticism attributes of the user**

77. As described above (*See supra* VIII.A.1.a), Lofi clearly teaches a various activities or drills are to be performed during a fitness test. Lofi provides instructions for a plurality of tests, such as strength, flexibility, endurance, reaction time, and balance tests. Components of these tests include various repetitive exercises (*e.g.*, running, bicycling, repetitive movements by contraction of the abdominal muscles). (*Id.* at 1:7-10.) Thus, each test represents a drill. Accordingly, Lofi renders claim 6 obvious.

**d) Claim 7 – The method of claim 1, wherein the first instructions and the second instructions include a pre-defined ordering of drills that are configured to be provided to the user during a single workout session.**

78. As described above (*See supra* VIII.A.1.a), Lofi clearly teaches a pre-defined ordering of activities, and those activities or drills are to be performed during a single session. Lofi describes the sequential workflow: “According to an operating procedure, the person settles in front of the terminal . . . Once this stage is completed, the different measurements are implemented . . . Subsequently, the following tests are carried out: measurement of reflexes, measurement of the strength of upper limbs, measurement of abdominal strength, measurement of flexibility, measurement of strengths of lower limbs and measurement of endurance.” (*Id.* at 11:9-18.) Lofi also teaches various repetitive exercises (*e.g.*,

running, bicycling, repetitive movements by contraction of the abdominal muscles) corresponding to each of these tests. (*Id.* at 1:7-10.) Thus, each fitness test represents a drill, and the order of the tests may be determined prior to commencing the workout session. Lofi further describes an automated process for assessing fitness wherein the procedure is quite rigid and follows a set routine.

## **B. Overview of Maeueler**

79. Maeueler (Ex. 1003) was published on May 25, 2011. Thus, Maeueler qualifies as prior art based on my understanding that the '930 patent's earliest possible priority date of June 4, 2012.

80. Maeueler describes a “fitness test system for determining a fitness test result that is indicative of a user’s physical fitness.” (*Id.* at [0001].) Maeueler describes that a motivation for the device is to address the large number of people that recognize the importance of physical fitness but suffer from health problems due to inactivity. Further, it notes that “The ability to monitor and test the personal level of fitness is believed to be an important motivating factor.” and that it is important that the “fitness test properly reflects the fitness state of the person taking the test.” (*Id.* at [0003].) Thus, Maeueler describes the importance of physical fitness, of monitoring, and of providing meaningful metrics. It further describes other approaches by noting that many other tests exist, but there are substantial challenges to the complexity of using them, and that doing tests at a

gym or fitness center can be done with assistance or special hardware along with the associated expenses and lack of flexibility. Maeueller makes a strong case for overcoming the existing approaches with “a fitness assessment system suitable for personal use.” (*Id.* at [0005].)

81. The disclosure notes that “[t]here is widespread agreement among experts that there are five crucial components of physical fitness as far as it relates to health: endurance, strength, flexibility, balance, and body composition.” (*Id.* at [0004].) As noted in the previous section regarding Lofi, Maeueller too uses the term “fitness” as a broader term encompassing at least the attributes noted above – this is not the same as the specific narrow use of “fitness” in the “fitness sub-score” of the challenged patent. Specifically, the “endurance,” “strength,” and “flexibility” components of Maeueller would be classified at least as fitness-related sub-scores, and “balance” would be classified at least as athleticism-related sub-scores according to the claims of the ’930 patent.

82. Maeueller describes a fitness test system “suitable for use without assistance from an expert . . . .” (*Id.* at [0023].) This indicates that the system provides all necessary prompts to the users such that they can perform the activities on their own. It goes on to note that it is an “easy-to-use system which in embodiments is capable of providing guidance to the user, perform the actual measurements needed in order to perform the test, as well as performing the final

evaluation, that is to calculate fitness results.” (*Id.*) Specifically, “the user receives instructions on how to perform the test, *e.g.*, via visuals and sound and executes the test with the help of associated peripheral devices; the execution of the test is monitored by the system through the use of sensors.” (*Id.*) A representation of the device is shown in Figure 2, reproduced below. This embodiment comprises “a handheld computing device 20, an exercise mat 21 and a distance detecting device 22.” (*Id.* at [0028].) It also comprises a computer program (23) running the application on the portable computing device (20), along with a GPS sensor, (23) and pulse oximeter sensor (24).

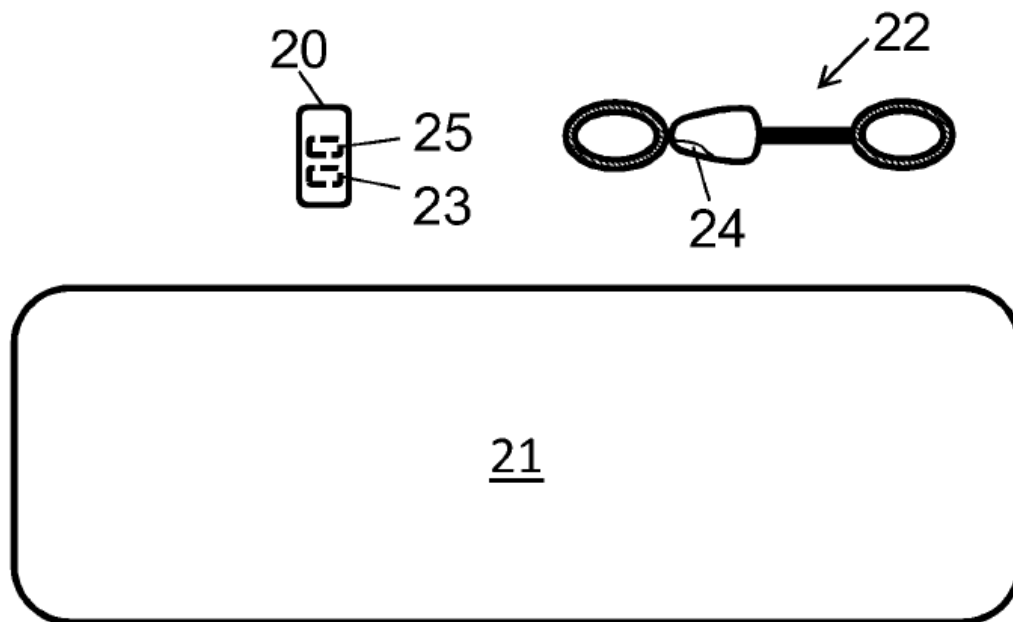


FIG. 2

(*Id.* at Fig. 2.)

83. With regard to the tests and scoring, Maeueler describes “In an embodiment, the collection of fitness tests comprises tests related to the following components of physical fitness: cardiovascular endurance, muscle strength, flexibility, balance, body composition. In order to be able to perform a complete fitness test, the computing module is programmed for execution of at least one fitness test associated with each of these components of physical fitness. Each component of physical fitness may even have more associated tests. Also alternative tests may be associated with the components of physical fitness.” (*Id.* at [0027].) With regard to assessing “Cardiovascular endurance,” the disclosure notes that multiple alternative tests exist and describes an example where “The endurance is tested by estimating the maximal oxygen consumption (VO<sub>2</sub>max) of the user. This can be tested by a run test, a walk test or a step test.” (*Id.* at [0031].) Instructions are provided during the test: “the computing module instructs the user to start running. Any type of feedback, e.g., audiovisual may be provided during the run.” (*Id.* at [0032].) With regard to assessing “Muscle strength,” the disclosure notes that it can “be tested by three muscle tests relating to the upper body, lower body and core body,” and that in one example a “result related to these three tests can be obtained by averaging the result of each of the three tests.” (*Id.* at [0037].) In example tests, the user can assess upper body with push-ups, wherein through the “use of audio or visual feedback, the user can be instructed as

to the rhythm of the push-ups.” (*Id.* at [0038].) Similarly, techniques for core and lower body can be assessed using curl-ups and wall-sit tests, respectively using the described system. With regard to “Flexibility,” “the flexibility test may in embodiments be tested by averaging the test result of two flexibility tests: a sit-and-reach test and a shoulder flexibility test.” (*Id.* at [0041].) Again, the system provides instructions and a sensor, in this case the automated measuring device, is used to gather data for assessment. And, with regard to “Balance,” Maeueller notes that balance can be assessed using the Stork balance stand test in conjunction with the pressure sensing exercise mat of the described invention. The disclosure also notes a variety of alternative embodiments including tests, displays, computing, peripheral devices, and the like. It also notes that the scores may be provided for individual tests (*i.e.*, sub-scores) or as an “aggregate fitness index” (*Id.* at [0051].)

## **1. Maeueller’s Disclosure Mirrors the Challenged Claims**

### **a) Claim 1 – A computer-implemented method comprising:**

84. Maeueller teaches a computer-implemented method. Figure 1 of Maeueller, reproduced below, shows a schematic representation of the components of an embodiment of Maeueller’s the fitness test system. The corresponding description notes “The system comprises a computing module 1. The computing module is connected to a collection of fitness test 2, where the collection contains

tests related to a plurality of components of physical fitness.” (*Id.* at [0024].)

Further, “The computing module 1 is programmed for upon selection of a fitness test, either by the user or as part of a test program, to determine the group of input parameters associated with the fitness test 2 and based on the input parameters determined by the computing module itself or received through the communication line, and optionally the user data, to calculate a fitness result 5 indicative of a user’s fitness related to the associated health-related component.” (*Id.* at [0025].)

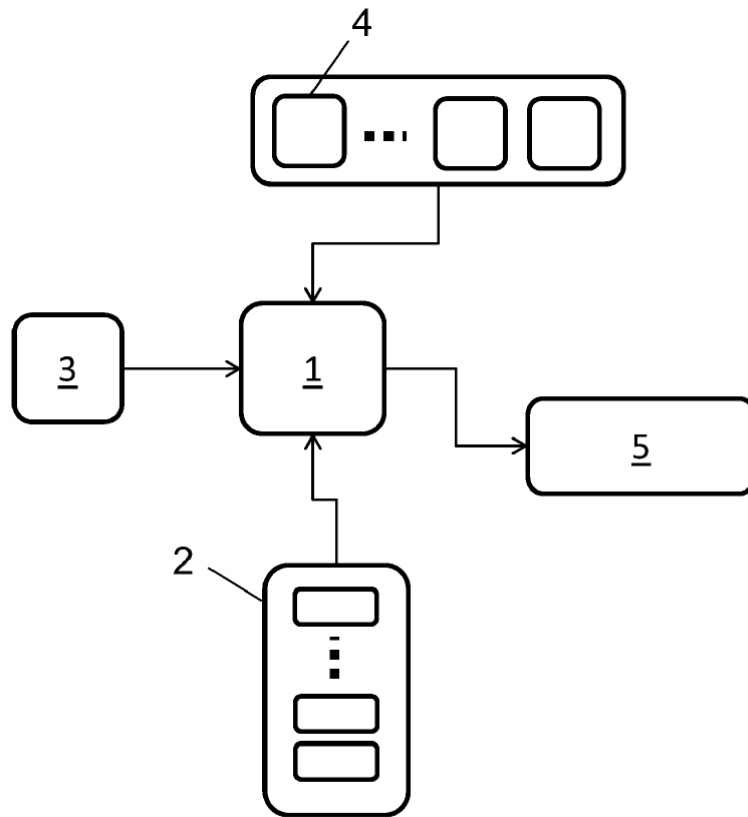


FIG. 1

(*Id.* at Fig. 1.)

**(i) providing first instructions to a user to perform a first athletic movement;**

85. Maeueller clearly describes providing instructions to the user to perform athletic activities or movements. Maeueller notes “In a general embodiment, the overall functionality of the fitness system is that the user selects a test or is prompted by the system which test should be next; the user receives instructions on how to perform the test, e.g., via visuals and sound and executes the test with the help of associated peripheral devices; the execution of the test is monitored by the system through the use of sensors; upon execution of the test, the user is presented with the test result.” (*Id.* at [0023] (emphasis added).) The invention discloses providing instructions for the various tests, thus it certainly includes providing a first set of instructions for a first athletic movement, just as it also provides instructions for subsequent activities. Maeueller further goes on to state: “To initiate a fitness test, the user runs a computer program implemented by the handheld computing device. In an embodiment, the computing module stores instructions associated with the tests and presents the instructions to the user to orchestrate the tests.” (*Id.* at [0029] (emphasis added).) This makes clear that the computing module (i.e., handheld computing device) provides instructions to the user instructing them how to perform the activities.

86. One such example is for the running activity which is classified as cardiovascular endurance. Here, “The test may be performed by instructing the

user to find an area suitable for running 12 minutes. When this is done, the computing module instructs the user to start running.” (*Id.* at [0032].) The disclosure further goes on to note that “Any type of feedback, e.g., audiovisual may be provided during the run.” (*Id.*) Clearly Maeueler is providing a set of instructions for the athletic activity.

87. In another example, Maeueler describes providing instructions for muscle strength test activities. “In an embodiment is the muscle strength tests performed by using a peripheral device in the form of an exercise mat 21, communicatively connected to the handheld device 20. The exercise mat may comprise pressure sensors and proximity sensors located in the mat. Additionally, the exercise mat may comprise a display, which may be used as an alternative to the display on the handheld computing module in order to present instructions and information to the user.” (*Id.* at [0037].) The instructions are provided by the handheld device in one embodiment, and/or the exercise mat in another embodiment. In a specific strength test for the upper body, “The strength of the upper body can be tested by counting the number of push-ups that can be performed according to a prescribed rhythm. In order to perform the test, the user may position his or her hands on the exercise mat. By use of audio or visual feedback, the user can be instructed as to the rhythm of the push-ups.” (*Id.* at [0038].) This clearly describes providing instructions for athletic movements.

And it again is evident that the instructions would be provided to the user as they perform the activity.

**(ii) receiving, from a sensor, first activity data representing the first athletic movement;**

88. In describing the tests, Maeueller states “the user receives instructions on how to perform the test, e.g., via visuals and sound and executes the test with the help of associated peripheral devices; the execution of the test is monitored by the system through the use of sensors.” (*Id.* at [0023] (emphasis added).) This statement makes it apparent that the athletic activities or movements are monitored by sensors. Then, Maeueller states that “upon execution of the test, the user is presented with the test result.” (*Id.*) Thus, the sensor data is clearly received by a computing device of the test system and utilized in generating the corresponding test results that are reported.

89. Maeueller describes the use of sensors that are integrated with the system to assess aspects of the athletic activities in the fitness tests. The disclosure notes that for one embodiment, “at least one of the peripheral devices is an exercise mat which contains one or more sensors.” (*Id.* at [0013].) A representation of this sensor-integrated exercise mat is shown in Figure 3, reproduced below. The mat is further described as:

“Figure 3 schematically illustrates a peripheral device in the form of an exercise mat 21. In an embodiment, the exercise mat comprises a display 30, such as a flexible display, and a number of sensors in the

mat. In the illustrated embodiment, two types of sensors are present, pressure sensors and a proximity sensor. The pressure sensors 32 may be located in marked areas 31 intended for positioning of the feet. In the illustrated embodiment, three sensors per foot are used, however other numbers and other configuration of sensors may be used. Additional pressure sensors may also be placed at other positions within the mat. In general even a net or grid of sensors may be positioned in an area of or in the entire exercise mat. Moreover, a proximity sensor 33 is illustrated. The proximity sensor may be an ultrasonic sensor capable of detecting distance, and thus of variations in distance, for detecting and counting the number of pushups and possibly curl-ups. In an embodiment, the curl-ups may also be counted by use of pressure sensors, e.g., the sensors 32 in the foot area or dedicated sensors placed at appropriate positions. As an alternative to pressure sensors, load cells may be used. The sensors and the display may be connected to a controller 34 positioned in the mat. The controller may also be implemented by the computing module, in which case, the sensors and the display are directly connected to the computing device or connected to a communication unit. In an embodiment, the computing module may also be, or additionally be, provided in the mat. The mat may be wirelessly connected to other peripheral devices; alternatively the mat may be connected via a cable connection.” (*Id.* at [0047] (emphasis added).)

This description makes evident that a variety of sensors are integrated into the system specifically configured for athletic activities that the user is instructed to perform, and that the computing unit receives the data from these sensors and relates that data to the specific activities being performed.

90. The example balance test that utilizes the pressure sensors in the exercise mat is described as: “The balance test may in embodiments be tested by a single test, the Stork balance stand test. In an embodiment, the balance test is performed by using a peripheral device in the form of the exercise mat. The test is

used to measure balance ability of the body. It is done by standing on the ball of one foot while the hands are kept on the hips and the foot of the non-supporting leg touches the knee of the supporting leg. The input is the time during which this position is maintained statically or without much movement. This can be determined by use of pressure sensors in the exercise mat.” (*Id.* at [0044] (emphasis added).) Here the provided instructions for the athletic activity relate to “standing on the ball of one foot while the hands are kept on the hips and the foot of the non-supporting leg touches the knee of the supporting leg,” and a sensor in the mat is used to collect data that is received by the computing unit to calculate an associated time parameter for when the user is able to maintain the pose.

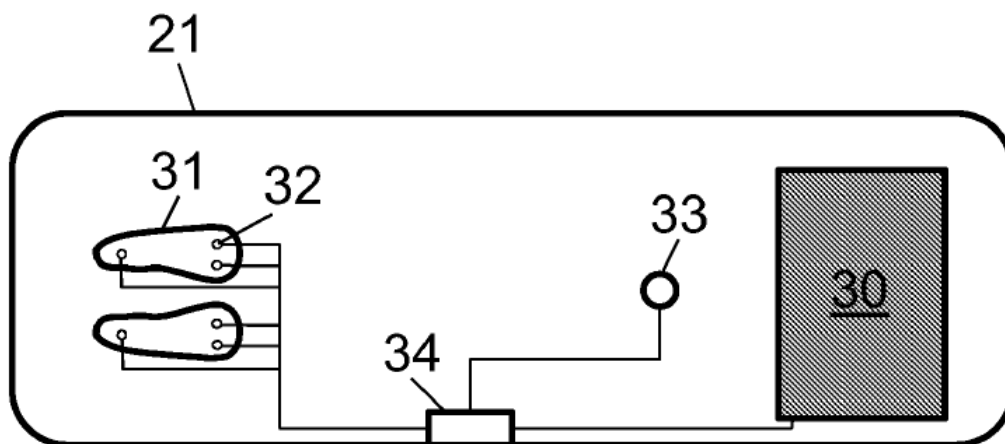


FIG. 3

(*Id.* at Fig. 3.)

91. The disclosure also notes that in an embodiment, “at least one of the peripheral devices is a distance detecting device suitable for measuring the distance

between different body parts e.g., between the user's fingers and/or between the user's fingers and toes. However, other distances such as waist circumference, height, etc., could be measured with the distance detecting device." (*Id.* at [0014].)

A representation of this sensor-integrated wearable distance measuring device is shown in Figure 4, reproduced below, and described in more detail as:

"Figure 4 schematically illustrates a peripheral device in the form of a distance detecting device. The figure schematically illustrates the attachment of the distance measuring device between the user's wrists and between the user's wrist and foot. In an embodiment, the device comprises a central unit 40 and two bands 41 suitable for attachment to a hand or foot. One band is attached to the central unit 40 and the other band is attached to a distance detecting unit 42, such as a cable connected also to the central unit 40. The device may implement a calibration routine to be able to use the device with different people. For the shoulder flexibility test this may be done by touching the tips of the middle fingers while keeping the forearms including hands in one straight line and by detecting the length 43 of the cable extension. Additionally, the device may comprise an oximeter 24 for measuring the heart rate of the user from the user's finger. Similar to the mat, the distance detecting unit may support wireless communication or cable connection to the computing module via a communication unit 44." (*Id.* at [0048] (emphasis added).)

This is again a clear example of sensors are integrated into the system configured for athletic activities that the user is instructed to perform and that the computing unit receives the data from these sensors and relates that data to the specific activities being performed.

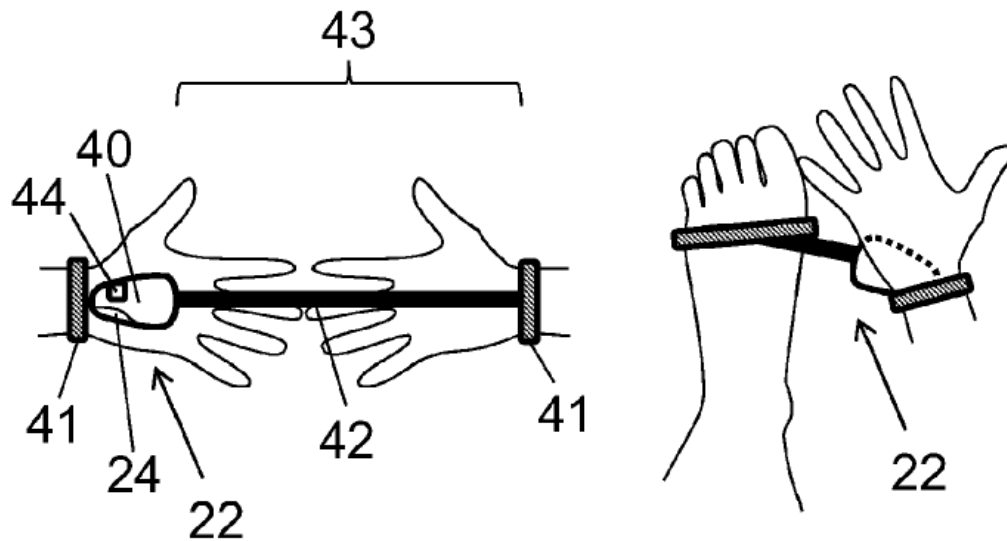


FIG. 4

(*Id.* at Fig. 4.)

92. Maeueller describes integrating multiple peripheral devices into the fitness test system: “In an important embodiment, the fitness system comprises an exercise mat and a distance detecting device, and optionally one or more additional peripheral devices. Both an exercise mat and a distance detecting device can be made by use of a low bill of materials. However, the invention is not limited to use of specific types of peripheral devices.” (*Id.* at [0014].)

**(iii) calculating with a processor, based on the first activity data, a first combinatory fitness-athleticism score;**

93. Maeueller’s invention is described as comprising “a computing module for accessing a collection of fitness tests, the collection of fitness tests comprises fitness tests related to a plurality of components of physical fitness, each fitness

test is associated with a group of input parameters to be determined, and wherein each input parameter is associated with one or more peripheral devices and/or with the computing module; one or more peripheral devices, the one or more peripheral devices being communicatively connected to the computing module, and the one or more peripheral devices being adapted to measure one or more input parameters; wherein the computing module is programmed for upon selection of a fitness test to determine the group of input parameters associated with the fitness test and based on the determined input parameters to calculate and/or present a fitness test result indicative of a user's fitness related to a component of physical fitness." (*Id.* at [0007] (emphasis added).) This statement makes it evident that the system comprises a computing device with a programmable processor that uses sensor data associated with the activities to calculate scores or test results related to the user's physical fitness (noting that fitness has a broad meaning here as described above).

94. The tests are intended to assess different aspects of physical fitness (in the broad sense of Maeueller), and that each provides one or more scores related to one or more aspects of "fitness" or "athleticism" (as defined by the claims of the '930 patent). One or more such tests could be utilized to generate scores corresponding individually to "fitness" and "athleticism." Thus, using Maeueller's computing module, a user may select two components of physical fitness to assess

(e.g., flexibility and balance) and perform the exercises associated with each test while being monitored with sensors. Maeueller's computing module calculates and presents to the user a first combinatory score. The user thus may receive a numerical fitness test result reflecting a combination of the flexibility and balance attributes being evaluated. Additionally, a user receives an index score for each test, which represent separate sub-scores. (*Id.* at [0051].) The index score for the flexibility test represents a fitness sub-score while the index score for the balance test corresponds to an athleticism sub-score.

95. While the '930 patent notes that a combinatory score could be simply showing the two scores together as shown in Figure 12 of the '930 patent above, Maeueller further describes an example of generating a combinatory score. Maeueller describes that "there is widespread agreement among experts that there are five crucial components of physical fitness as far as it relates to health: endurance, strength, flexibility, balance, and body composition." (*Id.* at [0004].) The disclosure then notes that "these five components of physical fitness are the key components with respect to the person's health state. By testing all five components, a comprehensive test which reflects the level of physical fitness of the user can be provided." (*Id.* at [0010] (emphasis added).) By combining the results from all tests (or a subset of the tests as a POSITA would recognize), a combinatory score reflecting the level of physical fitness of the user is disclosed.

Maeueller discloses a subset of the fitness tests as “computing module is programmed for determining input parameters related to at least one fitness test” (*Id.* at Claim 3 (emphasis added).) A POSITA would understand that this corresponds to at least two unique measurements generated by the device for a single activity corresponding to endurance, strength, and/or flexibility (*i.e.*, fitness sub-score) and balance (*i.e.*, athleticism sub-score).

96. In example activities of Maeueller, the user is assessed for their “Endurance,” “Strength,” and “Flexibility,” which would be classified as “fitness” (as defined in the claims of the ’930 patent). The challenged patent describes a fitness-related sub-score as “one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user.” (Ex. 1001 at Claim 1 (emphasis added).) In other example activities of Maeueller, the user is assessed of “Balance,” which would be classified as “athleticism” (as defined in the claims of the ’930 patent). The challenged patent describes an athleticism-related sub-score as “one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute and a balance athleticism attribute of the user.” (*Id.* (emphasis added).) The raw or processed data corresponding to these activities is data that is already in the computing device, and thus, if not expressly disclosed, presenting any of these

results would have been trivial to display to the user and correspond to a sub-score and/or a combinatory score.

97. Maeueller further describes displaying the results or scores related to each test result as “Figure 5 illustrates an example of a graphical visualization of the fitness test result. Each health-related component is presented by a column: cardiovascular endurance 50, muscle strength 51, flexibility 52, balance 53, body composition 54 and an aggregate fitness index 55.” (Ex. 1003 at [0052].) Figure 5, reproduced below, shows an example visualization of scores related to the various tests.

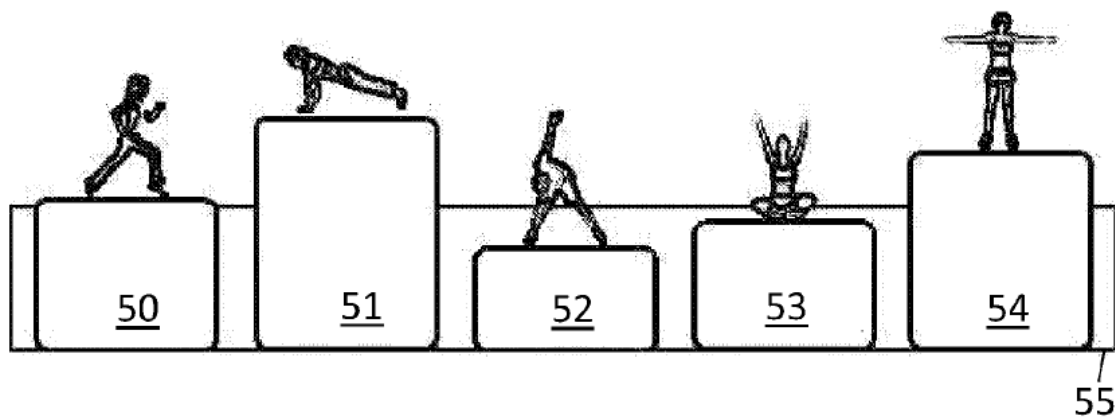


FIG. 5

(*Id.* at Fig. 5.)

98. The '930 patent makes it clear that it is NOT necessary to generate a single combined number or score, and that “In certain embodiments, the combinatory 35 score may be represented by the two individual sub-scores, such as

shown in FIG. 12.” (Ex. 1001 at 22:34-36 (emphasis added).) Thus, simply reporting a value corresponding to one of endurance, strength, and flexibility, along with a value corresponding to balance satisfies a “combinatory fitness-athleticism score” (as shown in Figure 5 of Maeueller above). When this corresponds to the first activity, and the data comes from that first activity, then it is clearly “a first combinatory fitness-athleticism score.” Further, should a single value for the combinatory score be desired, the ’930 patent does not require a complex approach to calculating a single score—it notes that “In one embodiment, a plurality of sub-scores, such as including the athleticism sub-score and the athleticism sub-score may average, summed, or otherwise combined to form a single score.” (*Id.* at 22:38-41.) Thus, it would have been obvious and trivial to a POSITA to combine the sub-scores into a single number if so desired. And, in fact Maeueller expressly discloses: “The result of a fitness test may be represented by a fitness index in the form of a numerical score value, such as a value ranging from 0 to 5 for each of the components of physical fitness, as well as a combined (average or weighted average) aggregate fitness index.” (Ex. 1003 at [0051] (emphasis added).)

- (iv) providing, in response to a triggering event, second instructions to the user to perform a second athletic movement;**

99. Maeueller discloses a “collection of fitness tests comprises fitness tests related to a plurality of components of physical fitness. By testing a plurality of different components of physical fitness a multi-dimensional test result may be obtained which assists the user in identifying components which are at satisfactory level as well as components which need improvement.” (*Id.* at [0010].) This collection of fitness tests “comprises tests related to the following components of physical fitness: cardiovascular endurance, muscle strength, flexibility, balance, body composition.” (*Id.*) Maeueller describes a particular order of fitness test activities and their associated athletic motions. For one example: “In a particular embodiment, tests which require that the user is not too tired may be performed early in the succession of tests, in an example the balance test may be performed first, then the muscle strength tests, then flexibility tests and next the endurance test.” (*Id.* at [0030].) In this example, instructions associated with a first athletic activity or movement for the balance test would be the first instructions, and instructions associated with a second athletic activity or movement for the muscle strength test would be the second instructions.

100. Completing one activity would be the “trigger event” to begin the next activity in the sequence, and the instructions provided for that next activity correspond to the “second instructions to the user to perform a second athletic movement.” As a specific example, the completion of the first test in a series of

five total fitness tests in a single workout session serves as a triggering event, prompting the computing device to provide the user with a second set of instructions pertaining to the second fitness test.

101. In the disclosed testing system, “the computing module is programmed for automatic coordination of and interaction with peripheral devices to determine the input parameters and calculate the fitness test result.” (*Id.* at [0011]), thus indicating that computing system manages the workout session and coordinates the order of activities, the instructions provided, and the data collection. It further states “By ensuring that data is collected automatically and that the collected data is automatically used by the computing module, it can be ensured that data is registered correctly and that the result is calculated correctly.” (*Id.*) In this context, “registered correctly” means ensuring that the acquired sensor data matches with the appropriate activity. Thus, this inherently means that the computing system is instructing the user to follow a prescriptive routine, providing instructions as the user goes along, acquiring the appropriate data from the relevant sensors on the appropriate peripheral device, and instructing the start of the next activity after ensuring completion of the previous activity (*i.e.*, the trigger event).

102. Maeueller also teaches that based on “analysis of the received sensor signals, the system may further be programmed to check the correctness of the performed movement, as well as to give instructions on how to perform a given

test in the event it is detected that the user's movements are incorrect.” (*Id.* at [0050].) The evaluation of the incorrectness of a user's form while performing a specific test may thus also serve as a triggering event to issue a second set of instructions to the user.

**(v) receiving, from the sensor, second activity data representing the second athletic movement;**

103. As described above, one of the previously described activities in a series corresponds to the first athletic movement activity, its sensor data correspond to first activity data, and its scores correspond to the first combinatory score. A POSITA would understand that a following activity in the sequence corresponds to the second athletic movement activity, its sensor data correspond to second activity data, and its scores correspond to the second combinatory score in the same as was for the first activity. According to Maeueller, “the execution of the test is monitored by the system through the use of sensors” and “upon execution of the test, the user is presented with the test result.” (*Id.* at [0023].) Thus, a user may select two components of physical fitness to assess and perform the exercises associated with each test while being monitored with sensors. Maeueller's computing module receives both the collected first activity data corresponding to the first test (*e.g.*, flexibility) as well as second activity data corresponding to the second test (*e.g.*, balance).

**(vi) calculating, with the processor, based on the second activity data, a second combinatory fitness-athleticism score,**

104. In the same way as described above for the first combinatory score, Maeueller calculates a second combinatory score based on the received second activity data corresponding to a fitness test.

105. A POSITA would understand that one or more of the tests described in Maeueller would be clustered in groups, each group comprising tests related to assessing aspects of both athleticism and fitness (and thus generating the associated sub-scores and combinatory score). Doing so would be obvious, and is in fact expressly described in Maeueller as previously noted. In this scenario, one group corresponds to the first athletic activity, and the second group corresponds to the second athletic activity. A user may be instructed to complete two tests (*e.g.*, related to flexibility and balance) and Maeueller's computing module subsequently calculates and presents to the user a first combinatory score. A user may then further receive instructions for another fitness test. In an exemplary endurance test described by Maeueller, wherein a user is instructed to run for 12 minutes, the user may be monitored by one or more peripheral devices collect heart rate data and speed data. Upon completion of the test, Maeueller's computing module calculates a fitness index numerical score (*i.e.*, a second combinatory score) that may be a combination of the endurance and speed attributes being assessed.

106. It should be noted that there is nothing in the '930 patent limiting the athletic activity or athletic movement to a single drill or test. In fact, the challenged patent explicitly states: “The athletic movement may comprise a plurality of drills configured to test a plurality of fitness attributes and/or a plurality of athleticism attributes of the user.” (Ex. 1001 at Abstract (emphasis added).) Thus, the clustering of multiple tests in Maeuler to “test a plurality of fitness attributes and/or a plurality of athleticism attributes of the user” is completely consistent with the meaning of “athletic movement” in the claims of the challenged patent.

- (vii) wherein the first and the second combinatory fitness-athleticism scores each comprise a fitness sub-score and a separate athleticism sub-score of the user, wherein the fitness sub-score is calculated, by the processor, using one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user, and wherein the athleticism sub-score is calculated, by the processor, using one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute and a balance athleticism attribute of the user.**

107. The combinatory scores are the result of a user completing an endurance, strength, flexibility, and balance tests. As described above, an aggregate score is presented to the user as well as individual scores for each test. The scores for Maeuler’s strength, flexibility, and endurance tests each correspond

to the claim's fitness sub-score while Maeueller's scores for its balance test corresponds to the claim's athleticism sub-score.

- b) Claim 5 – The method of claim 1, wherein the first athletic movement comprises predefined criteria, the method further comprising: providing the first instructions to the user to perform, during a first time period, the first athletic movement.**

108. In Maeueller, there is certainly a disclosure of predefined criteria for athletic movements, and providing instructions during the period of the activity. One such example describes comparing motion to a particular criteria (e.g., correctness of the motion) and performing instructions to the user during the time period in which they are performing the activity: “Moreover, from analysis of the received sensor signals, the system may further be programmed to check the correctness of the performed movement, as well as to give instructions on how to perform a given test in the event it is detected that the user's movements are incorrect.” (Ex. 1003 at [0050].) This statement clearly identifies a criteria, assessment of performance related to that criteria during an athletic activity, and real-time feedback with instructions to the user to correct their movement.

109. Maeueller also describes other examples of providing instructions for activities during the time period in which they are performing the activities. One such example is for the previously noted running activity, wherein “The test may be performed by instructing the user to find an area suitable for running 12

minutes. When this is done, the computing module instructs the user to start running.” (*Id.* at [0032].) As noted above, Maeueller is providing a set of instructions for the athletic activity. And further Maeueller is making it clear that such instructions are performed during the time period in which the activity is occurring. The first athletic movement thus includes the predefined criteria of running, and 12 minutes constitutes a first time period.

110. In another example, Maeueller describes providing instructions for muscle strength test activities as detailed above. (*See* Section VIII.B.1.a *supra.*) Maeueller notes that “the exercise mat may comprise a display, which may be used as an alternative to the display on the handheld computing module in order to present instructions and information to the user.” (*Id.* at [0037].) It again is clear that the instructions would be provided to the user as they perform the activity or athletic movement.

111. Should the Patent Owner contend that Maeueller does not expressly disclose providing these instructions during an activity, a POSITA would certainly understand that it is obvious to do so, especially since Maeueller expressly describes specialized equipment (*e.g.*, the exercise mat) instrumented with sensors for a specific activity and the inherent capability of these devices to provide instructions to the user. Accordingly, Maeueller renders claim 5 obvious.

**c) Claim 6 – The method of claim 1, wherein the first instructions and the second instructions include a plu-**

**rality of drills configured to test a plurality of fitness attributes of the user and a plurality of athleticism attributes of the user**

112. As described above (*See supra* VIII.B.1.a), Maeueller clearly teaches a various activities or drills are to be performed during a fitness test. Maeueller provides instructions for a plurality of tests, such as strength, flexibility, endurance, and balance tests. Components of these tests include various repetitive exercises (*e.g.*, running, push-ups). Thus, each test represents a drill. Accordingly, Maeueller renders claim 6 obvious.

**d) Claim 7 – The method of claim 1, wherein the first instructions and the second instructions include a predefined ordering of drills that are configured to be provided to the user during a single workout session.**

113. The fitness tests or drills of Maeueller with a given session are described as being performed in a particular, pre-determined sequence. The disclosure notes “In this example, the tests are performed in the following order: cardiovascular endurance, muscle strength, flexibility, balance and body composition.” (*Id.* at [0030].) Each fitness test represents a drill, and the order of the tests may be determined prior to commencing the workout session. The disclosure also notes that this order of may be adapted as desired, but still a predetermined sequence: “The invention is however not limited to this order, and different orders may be used in different implementations.” (*Id.*)

114. A specific example of an alternate predetermined sequence is described as: “In a particular embodiment, tests which require that the user is not too tired may be performed early in the succession of tests, in an example the balance test may be performed first, then the muscle strength tests, then flexibility tests and next the endurance test.” (*Id.*) This example makes clear it is intended to occur during a single workout session as it specifically orders the drills or tests to put balance tests before more strenuous activities. In this example, instructions associated with a balance test would be the first instructions and instructions associated with muscle strength would be the second instructions.

**e) Claim 12 – The method of claim 1, wherein the sensor comprises an accelerometer.**

115. Maeueller discloses that a user’s “[r]un or walk distance may be measured by use of an accelerometer or other motion detection devices” (*Id.* at [0049].) Accordingly, Maeueller renders claim 12 obvious.

**C. Overview of Kitagawa**

116. Kitagawa (Ex. 1004) was issued on October 12, 2010. Thus, Kitagawa qualifies as prior art based on my understanding that the ’930 patent’s earliest possible priority date of June 4, 2012.

117. Kitagawa describes a system for “measuring physical fitness, and more particularly relates to a system for measuring a user’s age on a basis of physical strength, with the system (1) including various types of exercise courses

that may have in them some elements of amusement so as to encourage the user to perform various exercises, and (2) being able to measure how long a user takes to progress through the exercises, so as to calculate the physical-strength age of the user and to assess which athletic activities the user is good or bad at.” (Ex. 1004 at 1:16-24.) The described system is intended for implementation at a recreation facility or similar.

118. Kitagawa identifies problems with traditional exercise equipment being used for assessment and seeks to provide “a health-factor measuring device that enables all members of a family, including elderly users, to take moderate exercise, and that also provides them with entertainment so that they can enjoy exercising . . . .” (*Id.* at 1:31-35.) Kitagawa describes the invention as “One objective of the present invention is to provide a system for measuring age on the basis of physical strength, with the system (1) having multiple, varying exercise courses that may have in them some elements of amusement, so as to encourage the user to perform the various exercises comfortably and sufficiently, and (2) being able to measure how long a user takes to complete each exercise course as well as the entire series of courses, so as to calculate the age of the user on the basis of the user’s physical strength and to assess how good or bad each of a user’s exercise abilities is.” (*Id.* at 2:14-24.) Thus, Kitagawa describes a system for an entertaining way to assess user’s physical fitness attributes through a variety of

specially designed courses each intended to assess a particular attribute, generating a score (such as time) for each course and a composite score that is referred to as the “physical-strength age.”

119. Figures 17 and 18, reproduced below, show an example arrangement of the various exercise courses from two viewpoints. As noted, the various exercises are intended to assess specific aspects of physical fitness: “The present invention’s system for measuring age on the basis of physical strength includes various types of exercise related devices/features that are structured such that a user can demonstrate a variety of physical abilities, including muscle strength at multiple places of his/her body, flexibility of the body, balance of the body, and agility of the body; a method by which an index of the amount of exercise that a user performs is measured by the extent to which each of a user’s physical abilities is demonstrated; exercise courses that each combine a unique set of exercises such that an index value for one exercise course is different from that for another exercise course” (*Id.* at 3:54-65 (emphasis added).) Kitagawa notes that for this embodiment, “for each type of exercise course, the following are indexed as measurements of exercise: physical abilities (i.e., leg strength, arm strength, flexibility of the body, balance of the body, and agility of the body), and the extent to which intelligence is demonstrated.” (*Id.* at 10:19-23.) A POSITA would understand that various different types of courses combined with various different

means to assess performance (including other sensors) for determining various attributes of physical fitness could be used.

Fig. 17

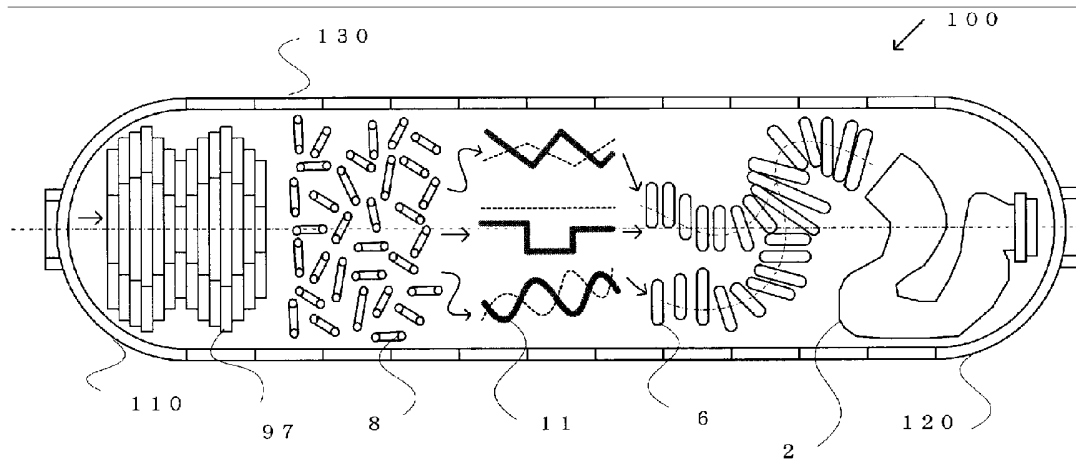
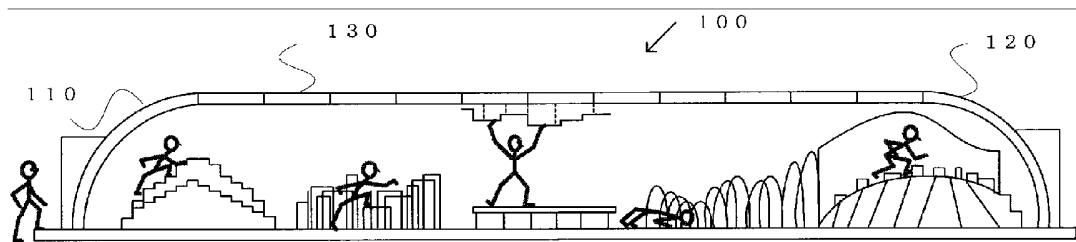


Fig. 18



(Ex. 1004 at Figs. 17 and 18.)

120. In performing the test, “Each user is then given a stopwatch and a pulse meter. The user then proceeds through each course, and records on the above-mentioned scorecard how much time is necessary for the user to complete each course; the user also records his/her pulse rates when starting and finishing each course.” (*Id.* at 8:43-47.) After completing the test, the user’s scores on each course as measured by the sensors (*i.e.*, time & pulse) and the associated index

values of each unique course are utilized to generate a score relating to the apparent “user’s age.” Kitagawa notes that “The system for calculating a user’s age on the basis of the user’s physical strength can be created using a personal computer (PC), for example.” (*Id.* at 8:63-65.)

121. As noted in the previous sections regarding Lofi and Maeueller, Kitagawa also uses the term “fitness” as a broader term encompassing at least the attributes noted above – this is not the same as the specific narrow use of “fitness” in the “fitness sub-score” of the challenged patent. Specifically, the “strength” and “flexibility” components of Kitagawa would be classified at least as fitness-related sub-scores, and “balance” would be classified at least as athleticism-related sub-scores according to the claims of the ’930 patent.

#### **IX. CLAIMS 1, 5-6, AND 7 OF THE ’930 PATENT ARE RENDERED OBVIOUS BY LOFI IN VIEW OF KITAGAWA**

122. The combination of Lofi and Kitagawa renders independent claim 1 and dependent claims 5-6, and 7 obvious. Specifically, it would have been obvious to combine Lofi’s monitoring of a user’s athletic activity using sensors with Kitagawa’s exercises that simultaneously assess multiple physical activity attributes with a reasonable expectation of success. Both Lofi and Kitagawa relate to systems and methods for personal fitness monitoring, generating a numerical value to help a user understand their fitness level, and encouraging a user to perform athletic activity to promote a healthy lifestyle. Indeed, substituting

Kitagawa's teachings into that of Lofi is simply the combination of familiar elements according to known methods to yield predictable results.

1. **Claim 1 – A computer-implemented method comprising: providing first instructions to a user to perform a first athletic movement; receiving, from a sensor, first activity data representing the first athletic movement; calculating with a processor, based on the first activity data, a first combinatory fitness-athleticism score; providing, in response to a triggering event, second instructions to the user to perform a second athletic movement; receiving, from the sensor, second activity data representing the second athletic movement; calculating, with the processor, based on the second activity data, a second combinatory fitness-athleticism score, wherein the first and the second combinatory fitness-athleticism scores each comprise a fitness sub-score and a separate athleticism sub-score of the user, wherein the fitness sub-score is calculated, by the processor, using one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user, and wherein the athleticism sub-score is calculated, by the processor, using one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute and a balance athleticism attribute of the user.**

123. Both Lofi (*see* Section VIII.A.1.a *supra*) and Kitagawa disclose similar methods to those disclosed in claim 1. If Patent Owner contends that Lofi does not teach a combinatory fitness-athleticism score based on the first activity data, Kitagawa discloses this element. As previously described (*See supra* VIII.C), Kitagawa describes various exercises are intended to assess specific aspects of physical fitness “such that a user can demonstrate a variety of physical abilities, including muscle strength at multiple places of his/her body, flexibility of the

body, balance of the body, and agility of the body.” (Ex. 1004 at 3:56-59 (emphasis added).) As shown in Table 3 below, flexibility, balance, and agility are physical attributes measured for each course and a user thus receives a combinatory score upon execution of each course the user is instructed to complete. (*Id.* at Table 3 (annotated red inlay).) For each course (which could represent a single activity), an index value is assigned related to each of these physical abilities. In this way, a given course provides a unique weighted combinatory score based on the above attributes. Kitagawa describes this as “a method by which an index of the amount of exercise that a user performs is measured by the extent to which each of a user’s physical abilities is demonstrated; exercise courses that each combine a unique set of exercises such that an index value for one exercise course is different from that for another exercise course” (*Id.* at 3:59-65.)

TABLE 3

| Course                        | Legs | Arms | Flexi-<br>bility | Balance | Agility | Intelli-<br>gence |
|-------------------------------|------|------|------------------|---------|---------|-------------------|
| Log Range                     | 6    | 4    | 9                | 10      | 4       | 6                 |
| Climb of Grief                | 7    | 6    | 6                | 6       | 8       | 6                 |
| Divided Pathway               | 7    | 2    | 9                | 9       | 9       | 2                 |
| Road of Torsion               | 7    | 3    | 6                | 10      | 5       | 3                 |
| Wall of Stagnation            | 4    | 8    | 7                | 7       | 4       | 4                 |
| Cave of Bones                 | 4    | 5    | 10               | 7       | 4       | 4                 |
| Stretch with Hanging<br>Rings | 4    | 6    | 10               | 3       | 5       | 2                 |

(Ex. 1004 at Table 3 (emphasis added).)

124. It should be noted that “Strength” and “Flexibility” from the above lists from Kitagawa correspond to fitness-related sub-scores according to the claims of the ’930 patent, and “Balance” corresponds to athleticism-related sub-scores according to the claims of the ’930 patent. Thus, a weighed combination (based on the above-noted index values for the various attributes for a given course) being used to generate a user’s score most certainly generates a “combinatory fitness-athleticism score” related to that activity.

Motivation to Combine Lofi and Kitagawa:

125. Prior to the earliest priority date of the ’930 patent, there were already numerous examples of sensing systems that monitored users while they instructed to perform various physical activities and subsequently provided quantitative metrics. (*See supra* ¶¶ 25-35 (citing Ex. 1012 [Wearable Systems for Monitoring Mobility-Related Activities in Chronic Disease: A Systematic Review], Ex. 1013 [Personal Digital Exercise Trainer for Managing, Monitoring and Recording the Exercise], Ex. 1014 [Nike + iPod webpage], Ex. 1015 [Nike + iPod manual], Ex. 1016 [Mechanics and Energetics of Level Walking with Powered Ankle Exoskeletons]).) A POSITA familiar with these fitness-monitoring devices and systems would have readily identified a multitude of ways in which to monitor and quantitatively report the overall physical activity of a user as well as specific sub-components.

126. Like Lofi, Kitagawa presents a system for measuring physical fitness. Both systems are intended to solve the same problem of easing the burden of physical fitness assessments by making it more systematic and streamlined using specialized equipment/facilities, instructions, analysis, and reporting. They are both in the same field of personal fitness monitoring and a POSITA would have looked to references like both Lofi and Kitagawa in developing a physical fitness assessment system.

127. The teachings of Kitagawa related to an algorithm for generating a combinatory fitness-athleticism score could be readily applied to the processing in the terminal of Lofi. As described above, Lofi clearly presents both fitness-related sub-scores and athleticism-related sub-scores in addition to a combinatory fitness-athleticism score, the latter of which can be simply presenting the two sub-scores side by side, or mathematically combining them. A POSITA would understand that Kitagawa's activity could comprise the user completing multiple courses that each have a plurality of index values (*see* Table 3 above) for the various attributes to generate unique sub-scores corresponding to fitness and athleticism, as well as a combinatory score. Such a technique could be readily applied to Lofi to assign index values to scores from various tests, and then generate a combinatory score in the same way as Kitagawa.

128. It would have been obvious to a POSITA to look to Kitagawa to incorporate simultaneous monitoring of multiple physical abilities (*e.g.*, flexibility, balance, agility) into Lofi's fitness tests and include Kitagawa's pulse meter to achieve this goal. Lofi already contemplates a user being monitored by one or more sensors during a fitness test. (Ex. 1002 at 8:8-10.) Incorporating the simultaneous monitoring of Kitagawa into Lofi's fitness tests would yield the predictable result of generating combinatory scores for every fitness test. For example, in Lofi's endurance test, a user may be simultaneously monitored and assessed for agility by incorporating the teaching of Kitagawa. Upon completion of the endurance test, a user may thus receive a score corresponding to endurance and a score corresponding to agility. The score for endurance represents a fitness sub-score while the score for agility corresponds to an athleticism sub-score. Accordingly, it would have been obvious to incorporate a specific assessment of agility into Lofi's fitness tests with a corresponding score based on the user's collected activity data, which would have been a simple addition with a high likelihood of success to provide a more comprehensive fitness evaluation for the user.

**2. Claim 7 – The method of claim 1, wherein the first instructions and the second instructions include a predefined ordering of drills that are configured to be provided to the user during a single workout session.**

129. Both Lofi (*see* Section VIII.A.1.a *supra*) and Kitagawa disclose similar methods to those disclosed in claim 7. If Patent Owner contends that Lofi fails to disclose a predefined ordering of drills, Kitagawa teaches this limitation. As previously described, Kitagawa describes a set of obstacle courses, wherein the courses are intended to be followed in a specific sequence. Thus, this is clearly a predefined order of activities or drills.

Motivation to Combine Lofi and Kitagawa:

130. A POSITA would recognize the benefits of incorporating Kitagawa’s teachings into Lofi’s tests to provide a more comprehensive fitness evaluation. A POSITA implementing Lofi would further understand the benefit of a consistent order of activities as presented in Kitagawa and could readily order the activities in such a way a part of the autonomous workflow. In fact, Lofi notes that it is not intended to be a one-off assessment for a user, but that the invention is intended to “facilitate their return on each terminal.” (Ex. 1002 at 11:5.) In order to have a consistent and meaningful comparison of the user’s performance over repeated uses of the system, a POSITA would understand that it is essential to have a predefined consistent ordering of activities or drills. Kitagawa’s exercise courses constitute a set of drills wherein each of them involves similar exercises that

challenge the same physical abilities, such as strength, flexibility, and agility. Ultimately, incorporating Kitagawa's teaching of a predefined ordering of exercises that repeatedly challenge the same physical abilities into Lofi's fitness tests for endurance, strength, flexibility, and balance is a simple substitution.

**X. CLAIMS 1, 5-7, AND 12 OF THE '930 PATENT ARE RENDERED OBVIOUS BY MAEUELER IN VIEW OF KITAGAWA**

131. The combination of Maeueler and Kitagawa renders independent claim 1 obvious and therefore renders dependent claims 5-7 and 12 obvious. Specifically, it would have been obvious to combine Maeueler's monitoring of a user's athletic activity using sensors with Kitagawa's exercises that simultaneously assess multiple physical activity attributes with a reasonable expectation of success. Both Kitagawa and Maeueler relate to systems and methods for personal fitness monitoring, generating a numerical value to help a user understand their fitness level, and encouraging a user to perform athletic activity to promote a healthy lifestyle. Indeed, substituting Kitagawa's teachings into that of Maeueler is simply the combination of familiar elements according to known methods to yield predictable results.

- 1. Claim 1 – A computer-implemented method comprising: providing first instructions to a user to perform a first athletic movement; receiving, from a sensor, first activity data representing the first athletic movement; calculating with a processor, based on the first activity data, a first combinatory fitness-athleticism score; providing, in response to a triggering event, second instructions to the**

**user to perform a second athletic movement; receiving, from the sensor, second activity data representing the second athletic movement; calculating, with the processor, based on the second activity data, a second combinatory fitness-athleticism score, wherein the first and the second combinatory fitness-athleticism scores each comprise a fitness sub-score and a separate athleticism sub-score of the user, wherein the fitness sub-score is calculated, by the processor, using one or more of an endurance fitness attribute, a flexibility fitness attribute and a strength fitness attribute of the user, and wherein the athleticism sub-score is calculated, by the processor, using one or more of a speed athleticism attribute, an agility athleticism attribute, a reaction athleticism attribute, a power athleticism attribute and a balance athleticism attribute of the user.**

132. Both Maeueller (*see* Section VIII.B.1.a *supra*) and Kitagawa disclose similar methods to those disclosed in claim 1. If Patent Owner contends that Maeueller does not teach a second combinatory fitness-athleticism score based on the first activity data, Kitagawa discloses this element. As previously described (*See supra* VII.C), Kitagawa describes various exercises are intended to assess specific aspects of physical fitness “such that a user can demonstrate a variety of physical abilities, including muscle strength at multiple places of his/her body, flexibility of the body, balance of the body, and agility of the body.” (Ex. 1004 at 3:56-59 (emphasis added).) As shown in Table 3 below, flexibility, balance, and agility are physical attributes measured for each course and a user thus receives a combinatory score upon execution of each course the user is instructed to complete. (*Id.* at Table 3 (annotated red inlay).) For each course (which could

represent a single activity or athletic movement), an index value is assigned related to each of these physical abilities. In this way, a given course provides a unique weighted combinatory score based on the above attributes. “Strength” and “Flexibility” from the above lists from Kitagawa correspond to fitness-relates sub-scores according to the claims of the ’930 patent, and “Balance” corresponds to athleticism-related sub-scores according to the claims of the ’930 patent. Thus, a weighted combination being used to generate a user’s score most certainly generates a “combinatory fitness-athleticism score” related to that activity.

TABLE 3

| Course                        | Legs | Arms | Flexi-<br>bility | Balance | Agility | Intelli-<br>gence |
|-------------------------------|------|------|------------------|---------|---------|-------------------|
| Log Range                     | 6    | 4    | 9                | 10      | 4       | 6                 |
| Climb of Grief                | 7    | 6    | 6                | 6       | 8       | 6                 |
| Divided Pathway               | 7    | 2    | 9                | 9       | 9       | 2                 |
| Road of Torsion               | 7    | 3    | 6                | 10      | 5       | 3                 |
| Wall of Stagnation            | 4    | 8    | 7                | 7       | 4       | 4                 |
| Cave of Bones                 | 4    | 5    | 10               | 7       | 4       | 4                 |
| Stretch with Hanging<br>Rings | 4    | 6    | 10               | 3       | 5       | 2                 |

(Ex. 1004 at Table 3 (emphasis added).)

#### Motivation to Combine Maeueler and Kitagawa:

133. Prior to the earliest priority date of the ’930 patent, there were already numerous examples of sensing systems that monitored users while they instructed to perform various physical activities and subsequently provided quantitative metrics. (*See supra* ¶¶ 25-35 (citing Ex. 1012 [Wearable Systems for Monitoring

Mobility-Related Activities in Chronic Disease: A Systematic Review], Ex. 1013 [Personal Digital Exercise Trainer for Managing, Monitoring and Recording the Exercise], Ex. 1014 [Nike + iPod webpage], Ex. 1015 [Nike + iPod manual], Ex. 1016 [Mechanics and Energetics of Level Walking with Powered Ankle Exoskeletons]).) A POSITA familiar with these fitness-monitoring devices and systems would have readily identified a multitude of ways in which to monitor and quantitatively report the overall physical activity of a user as well as specific sub-components.

134. Like Maeueller, Kitagawa presents a system for measuring physical fitness. Both systems are intended to solve the same problem of easing the burden of physical fitness assessments by making it more systematic and streamlined using specialized equipment/facilities, instructions, analysis, and reporting. They are both in the same field of personal fitness monitoring and a POSITA would have looked to references like both Maeueller and Kitagawa in developing a physical fitness assessment system.

135. The teachings of Kitagawa related to an algorithm for generating a combinatory fitness-athleticism score could be readily programmed for the processor of the computing module of Maeueller. Maeueller already presents both fitness-related sub-scores and athleticism-related sub-scores in addition to a combinatory fitness-athleticism score, the latter of which can be simply presenting

the two sub-scores side by side, or mathematically combining them. A POSITA would understand that Kitagawa's activity could comprise the user completing multiple courses that have a plurality of index values (*see* Table 3 above) for the various attributes to generate unique scores corresponding to fitness and athleticism, as well as a combinatory score. Such a technique could be readily applied to Maeueller to assign index values to scores from various tests, and then generate a combinatory score in the same way as Kitagawa.

136. In order to more comprehensively understand which components need improvement, it would have been obvious to a POSITA to look to Kitagawa and incorporate Kitagawa's simultaneous monitoring of multiple physical abilities (*e.g.*, flexibility, balance, and agility) into Maeueller's fitness tests to yield the predictable result of generating combinatory scores for every fitness test. As noted above, Maeueller already contemplates a user being monitored by one or more peripheral devices each having one or more sensors during a fitness test. (Ex. 1003 at [0013], [0024].) Incorporating the simultaneous monitoring of Kitagawa into Maeueller's fitness tests would yield the predictable result of generating combinatory scores for every fitness test. For example, in Maeueller's endurance test, a user may be simultaneously monitored and assessed for agility. Upon completion of the endurance test, a user may thus receive an index score corresponding to endurance and an index score corresponding to agility. The index

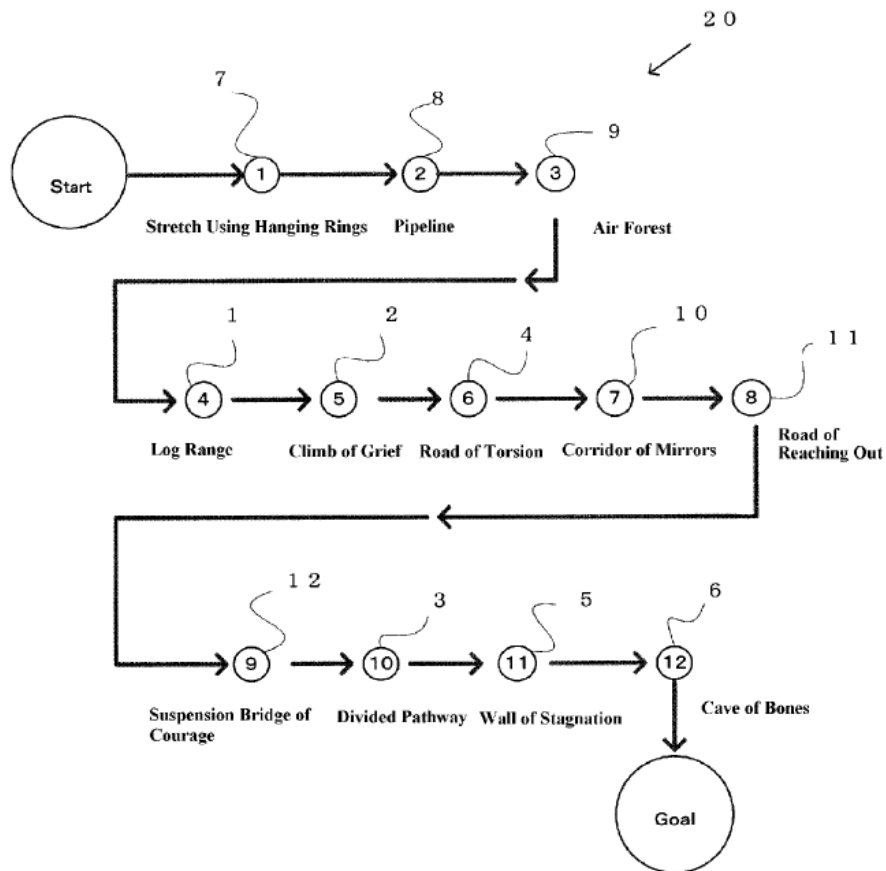
score for the endurance test represents a fitness sub-score while the index score for the speed or agility test corresponds to an athleticism sub-score. Accordingly, it would have been obvious to incorporate a specific assessment of agility into Maeueler's fitness tests with a corresponding index score based on the user's collected activity data, which would have been a simple addition with a high likelihood of success, to provide a more comprehensive fitness evaluation for the user.

**2. Claim 7 – The method of claim 1, wherein the first instructions and the second instructions include a predefined ordering of drills that are configured to be provided to the user during a single workout session.**

137. Both Maeueler (*see* Section VIII.B.1.d *supra*) and Kitagawa disclose similar methods to those disclosed in claim 7. If Patent Owner contends that Maeueler fails to disclose a predefined ordering of drills or activities, Kitagawa certainly teaches this limitation. Kitagawa shows a very specific example order of exercise courses in Figure 1, reproduced below. The figure shows a clear path from the beginning of the session at “Start” to the end of the session at “Goal,” with numbered, ordered exercise courses along the way as the user competes the circuit. As previously described, each course is “structured such that a user utilizes a variety of physical abilities, including muscle strength in multiple parts of his/her body, flexibility of the body, balance of the body, and agility of the body” (Ex. 1004 at 2:28-31 (emphasis added).) And, for each unique exercise course in the

sequence “the combination of the values of the indexes for each exercise course is different from the combination of values in each of the other exercise courses.” (*Id.* at 2:33-36.)

Fig. 1



(Ex. 1004 at Fig. 1.)

### Motivation to Combine Maeueler and Kitagawa:

138. A POSITA would recognize the benefits of incorporating Kitagawa’s teachings into Maeueler’s tests to provide a more comprehensive fitness evaluation. In order to have a consistent and meaningful comparison of the user’s

performance over repeated uses of the system, a POSITA would understand that it is essential to have a predefined consistent ordering of activities or drills. Kitagawa's exercise courses constitute a set of drills wherein each of them involves similar exercises that challenge the same physical abilities, such as strength, flexibility, and agility. Incorporating Kitagawa's teaching of a predefined ordering of exercises that repeatedly challenge the same physical abilities into Maeueller's fitness tests for endurance, strength, flexibility, and balance is a simple substitution. Specifically, this would be a simple substitution of exercises into Maeueller that combine multiple attributes of fitness and athleticism. For example, combining balance and flexibility could be as simple as standing on the exercise mat and performing the balance test as described in Maeueller, while also instructing the user to touch their toes and using the distance measurement exactly as described in Maeueller to measure flexibility. "The measuring device is attached to and spanned between a wrist and a foot." (Ex. 1003 at [0042].) The same or a different flexibility test could also be similarly combined with one of the described endurance or strength tests. Thus, based on the teachings of Maeueller, in light of the teachings of Kitagawa, a POSITA would find it obvious to incorporate the ordering of at least two activities that each comprise elements of athleticism and fitness that each provide individual sub-scores and combinatory scores. Doing so

would be a simple substitution of activities or a trivial to implement and obvious task of clustering of the activities already described in Maeueller.

139. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case. If required, I will appear for cross-examination at the appropriate time.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: January 4, 2023

A handwritten signature in black ink, appearing to read "Gregory S. Fischer", written over a horizontal line.

Dr. Gregory S. Fischer

# CURRICULUM VITAE

## **GREGORY S. FISCHER, PhD**

### **Primary Affiliation:**

Department of  
Robotics Engineering

### **Affiliate Appointments:**

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Research lab web pages:

<http://aimlab.wpi.edu>

<http://practicepoint.org>

LinkedIn:

<https://www.linkedin.com/in/gregfischer/>

Google Scholar:

<https://scholar.google.com/citations?user=N00MU6AAAAAJ>

## PROFESSIONAL EXPERIENCE

### **Education**

**Johns Hopkins University** – Baltimore, MD

**Ph.D., Mechanical Engineering** (July 2008)

*Doctoral Dissertation:* Enabling Technologies for MRI Guided Interventional Procedures - With Applications to Prostate Cancer Diagnosis and Therapy

*Advisor:* Gabor Fichtinger

*Dissertation Committee members:* Allison Okamura and Russell Taylor

**MSE, Mechanical Engineering** (May 2005)

*Master's Thesis:* Electromagnetic Tracker Calibration and Optimal Tool Design - With Applications to ENT Surgery

*Advisor:* Russell Taylor

*Thesis Committee:* Kevin Cleary, *Industry Collaborator:* Northern Digital, Inc.

**MSE, Electrical Engineering** (May 2004)

*Advisor:* Jerry Prince

**Rensselaer Polytechnic Institute (RPI)** – Troy, NY

**BS, Mechanical Engineering** (May 2002)

**BS, Electrical Engineering** (May 2002)

### **University Teaching-Related Work Experience**

2019 – present: Worcester Polytechnic Institute – Worcester, MA

William Smith Dean's Professor of Robotics Engineering (RBE), with appointments in & Mechanical Engineering, Biomedical Engineering, and Electrical Engineering.

Founding Director of WPI Automation and Interventional Medicine (AIM) Robotics Research Laboratory - <http://aimlab.wpi.edu/>

Director of PracticePoint @ WPI (2017 – present) - Healthcare cyber-physical systems research and development center - <http://practicepoint.org>

Research Focus: Medical devices, biomedical robotics, and computer integrated surgery with specific focus on: technologies and systems for MRI-guided surgical interventions, robot-assisted surgical manipulation, sensing wearable rehabilitation and assistive devices, and socially assistive personal healthcare robots. Development of sensors, actuator, control systems, electronics, embedded software, navigation software, communication frameworks, electromechanical design, and system architecture. Achieved clinical trials for MRI-guided prostate intervention system and pre-clinical trials for brain cancer neurosurgery system. Research support from NIH, NSF, and DoD.

Teaching Focus: Developed courses & custom laboratory hardware and taught courses in the RBE Unified Robotics core curriculum including RBE 3001 – Manipulation, RBE 3002 – Navigation. Developed and taught graduate courses including ME501/RBE501 – Robot Dynamics and RBE580/ME5205 – Biomedical Robotics. Implemented online offerings for these graduate courses. Advised a significant number of multidisciplinary Major Qualifying Projects, primarily in the area of medical devices, robotics, and healthcare cyber-physical systems.

2014 – 2019: Worcester Polytechnic Institute – Worcester, MA

Associate Professor of Mechanical Engineering with appointments in Robotics Engineering, Biomedical Engineering, and Electrical Engineering.

Faculty Director of HDI (2014 – 2017) – WPI's Healthcare Delivery Institute

2008 – 2014: Worcester Polytechnic Institute – Worcester, MA

Assistant Professor of Mechanical Engineering with appointments in Robotics Engineering, Biomedical Engineering, and Electrical Engineering.

**Other Work and Professional Experience**

2020 – present: AiM Medical Robotics – Ft Lauderdale, FL

Chief Science Advisor and VP of R&D: Co-founder and advisor of the start-up surgical robotics company. Licensed technology from WPI to commercialize an MRI-guided surgical robot for neurosurgery.

2015 – 2016: Harvard Medical School – Boston, MA

Visiting Associate Professor of Radiology at Brigham and Women's Hospital

On sabbatical for AY15/16 focusing on clinical translation of our robotic surgery research and exploring new collaborative research efforts.

2012 – present: Medical Motion Corporation – Boston, MA

CEO: Co-founder with WPI alumnus Gregory Cole of a medical device research instrumentation company. The focus is on developing and distributing custom-developed medical robot controller equipment, with our research instrumentation in over 35 international world class research facilities.

2006 – present: Surgisense Corporation – Bethesda, MD

CTO: Co-founder of an NIH SBIR-supported medical device company. The focus is on developing and commercializing “smart” sensing surgical instruments for guiding surgical procedures based on intraoperative sensor data and predictive data analytics. Products in development are intended to augment diagnostic colonoscopic imaging and guide colorectal cancer surgery.

2002 – 2008: NSF ERC CISST – Johns Hopkins University – Baltimore, MD

Graduate Student Researcher: Medical robotics and computer assisted interventions with the focus on my doctoral work on MRI-guided percutaneous therapy. Lab Manager and Researcher for Computer Integrated Surgical Systems Technology Engineer Research Center.

1999 – 2002: Bihler of America – North Branch, NJ

Summer Intern (four summers) / mechanical and electrical engineer working on automated manufacturing equipment. Implemented networked data acquisition and statistical process control systems, designed mechanical and electrical systems for industrial automation machinery, and performed troubleshooting and repair of production machinery electrical systems.

2001 – 2002: Rensselaer Polytechnic Institute – Troy, NY

Research in automation of biotech assay and eye simulator for eye tracking. Design of “smart” sensing surgical drill for spine surgery. Teaching Assistant for CAD course with instruction in Solidworks and PTC ProEngineer.

**Teaching Innovations****New Courses Developed**

**ME 5205 / RBE 580 – Biomedical Robotics** (1<sup>st</sup> offered: C-Term 2012 as an experimental special topics course, Became permanent RBE and ME course starting Spring 2014)

Developed a new special topics course focused on all aspects of medical robotics. Course combines lecture, journal review & discussion, and projects. Lecture and discussion topics include the following high level applications and corresponding underlying technologies: aspects of robotics related to medical robotics & computer-integrated surgery, rehabilitation robotics, assistive robotics, active prosthetics, lab automation, and others.

**ME 501 / RBE 501 – Robot Dynamics** (1<sup>st</sup> offered: Spring 2010)

Implemented a new graduate course in advanced robotics. The focus of the course is primarily on kinematics, dynamics and control of robotic manipulators with an introduction into how these techniques also apply to mobile robots. The course is interactive, combining lectures, team projects, and student presentations with class discussion of important journal manuscripts.

**RBE 3001 – Unified Robotics III - Manipulation** (1<sup>st</sup> offered: C-Term 2009)

Completely new course for the integrated Robotics Engineering curriculum. Co-developed and taught a new junior-level course focused on teaching aspects of robotic manipulation including serial manipulator kinematics, dynamics, motor control, sensing, and embedded software programming. Created curriculum, instructional materials, and custom laboratory hardware including a low-cost educational robot arm (EduArm) and corresponding drive circuitry and software library. The course was well received, despite the extended hours in the lab, with many students feeling that they “learned more in this course than any other they had taken.”

**RBE 3002 – Unified Robotics IV - Navigation** (1<sup>st</sup> offered: D-Term 2009)

Completely new course for the integrated Robotics Engineering curriculum. Co-developed and taught a new junior-level course focused on teaching aspects of mobile robots, including mobile robot kinematics, dynamics, sensor fusion, environment mapping, and path planning. Created curriculum, course materials,

custom lab hardware, and software libraries, including a low-cost mobile robot platform (EduBot) that integrates with the RBE 3001 arm hardware.

## **Significant Course Improvements**

### **RBE Undergraduate Curriculum**

Involved in regular meetings with the instructors of RBE1001 through RBE3002 to improve the content and delivery of material in the robotics sequence to better prepare the students. Recently overhauled the sequence to reallocate course material among the core courses. We have made changes to the focus of the lectures, adapted the sequencing in which material is presented, and continuously updated the laboratory hardware used.

### **RBE 3001 – Unified Robotics III - Manipulation**

Adapted the course from the preceding offerings based on our observations and student feedback. The lectures were reorganized, with time spent on improving the delivery of material. Labs were modified, and multiple generations of the custom lab hardware for the robotic arms were developed.

In Summer 2017, I developed all new education electronics hardware for the RBE 3001 course and a new set of redesigned robotic arms for the students – this was associated with a major course overhaul and shifting and modernizing the focus of the course. We continued to further modernize the course in following offerings.

In 2020 we overhauled the robot, electronics hardware, and software again as well as the associated labs and curriculum for this course. We incorporated contemporary topics including computer vision. The robot is now more capable, smaller, and lower cost. During the COVID-19 pandemic, the robot was designed to be taken home by students.

### **RBE 3002 – Unified Robotics IV - Navigation**

Adapted the course from the first offering based on our observations and student feedback. We have developed a new software framework for the students to use so that they can now better focus on the theoretical understanding of the material including navigation, planning, mapping and control without getting bogged down in the implementation. The labs were modified and a second and next generation of the custom lab hardware for the mobile robot and for the control circuitry was developed. This class has since been picked up by other faculty and further evolved.

## **Courses Taught**

### **Undergraduate Courses**

**RBE 3001 – Unified Robotics III - Manipulation** (Offered: C-Term 2009, C-Term 2010, A-Term 2010, C-Term 2011, A-Term 2011, A-Term 2012, A-Term 2013, A-Term 2014, A-Term 2016, A-Term 2017, A-Term 2018, C-Term 2021)

Junior level, third course in the 4-course Unified Robotics sequence with a focus on embedded systems, analog & digital circuits and robotic manipulator

modeling and control. Developed this course and a number of iterations of custom lab hardware, and continue to teach this course regularly.

**RBE 3002 – Unified Robotics IV - Navigation** (Offered: D-Term 2009, D-Term 2010)

Junior level, final course in the 4-course Unified Robotics sequence with a focus on system architecture, distributed systems, mapping, navigation, and mobile robot kinematics and dynamics. Helped to develop course, but taken on by other faculty whose research area is in mobile robots.

**Graduate Courses**

**ME 501 / RBE 501 – Robot Dynamics** (Offered: Spring 2010, Spring 2011, Spring 2012, Spring 2013, Spring 2014, Spring 2015 [hybrid], Fall 2015 [online], Spring 2016 [online], Spring 2017 [online], Spring 2018 [hybrid], Fall 2019 [hybrid])

Graduate course focused on teaching fundamentals of robotics, including advanced modeling and control robotic manipulators, representations in space, forward and inverses kinematics, velocity and force control, manipulator dynamics, and robot controller design. Developed and continue to teach this course regularly, and have online and hybrid offerings of the course.

**ME 5205 / RBE 580 – Biomedical Robotics** (Offered: C-Term 2012, C-Term 2013, C-Term 2014, A-Term 2014, B-Term 2016 [hybrid], B-Term 2018 [hybrid], D-Term 2020 [online], D-Term 2021 [online], D-Term 2022 [hybrid])

Graduate course focused on all aspects of medical robotics with a project-based focus. Topics include: aspects of robotics related to medical robotics & computer-integrated surgery, rehabilitation robotics, assistive robotics, active prosthetics, lab automation, and others. Developed and continue to teach this course regularly.

**Honors, Awards, and Recognition Related to Teaching**

- WPI Board of Trustees award for Outstanding Research and Scholarship (2021)
- ASME IDETC/CIE Computer-Aided Product and Process Design (CAPPD) Technical Committee Best Paper Award “Design Development and Characterization of a Wrap Spring Clutch/Brake Mechanism as a Knee Joint for an Assistive Exoskeleton” (2020)
- Inducted as Senior Member of National Academy of Inventors - NAI (2019)
- The WPI AIM Lab team presenting the MRI-compatible Neurosurgery Robot at the Hamlyn Symposium in London won Best Application Award (2019)
- The WPI AIM Lab team presenting the AMBF Simulation Framework won the Founder's Award: Best for Research Community (2019)
- IROS Conference Best Application Paper Finalist “A Real-time Dynamic Simulator and an Associated Front-end Representation Format for Simulating Complex Robots and Environments” (2019)
- Advisees received First and Third Place Graduate Research Innovation Exchange (GRIE) Awards in Robotics, Cyberphysical Systems, Electrical and Computer Engineering (2018)

*Katie Gandomi (1st Place), Marek Watenberg (3rd Place)*

- Finalist for Provost's Award for best Biomedical Engineering MQP (2018)  
*Designing a Wearable Shoulder Exoskeleton for Hemiparetic Patients*
- Honorable mention for Provost's Award for best Robotics Engineering MQP (2017)  
*MRI Compatible Optical Force Sensor*
- William Smith Foundation Dean's Professor in Mechanical Engineering (2016)
- Advisee received Second Place Graduate Research Innovation Exchange (GRIE) Award in Engineering for PhD level (2015)  
*Christopher Nycz*
- Provost's Award for best Biomedical Engineering MQP (2015)  
*Phlebot: Robotic Phlebotomist*
- Nominated for Morouzzi Young Faculty Award for Innovation in Undergraduate Education (2012 & 2013)
- Provost's Award Runner-up for Robotics Engineering MQP (2013)  
*Soft Robotic Exo-Musculature Upper Arm Orthotic for Rehabilitation*
- Provost's Award for best Biomedical Engineering MQP (2012)  
*Stroke Rehabilitation Robotic Glove*
- Provost's Award for best Robotics Engineering MQP (2012)  
*Robot for MRI Environment: Pneumatic Stepping Motor Design*
- Provost's Award for best Robotics Engineering MQP (2010)  
*Medical Robot Teleoperation and Haptic Feedback*

## **Publications and Scholarly Contributions**

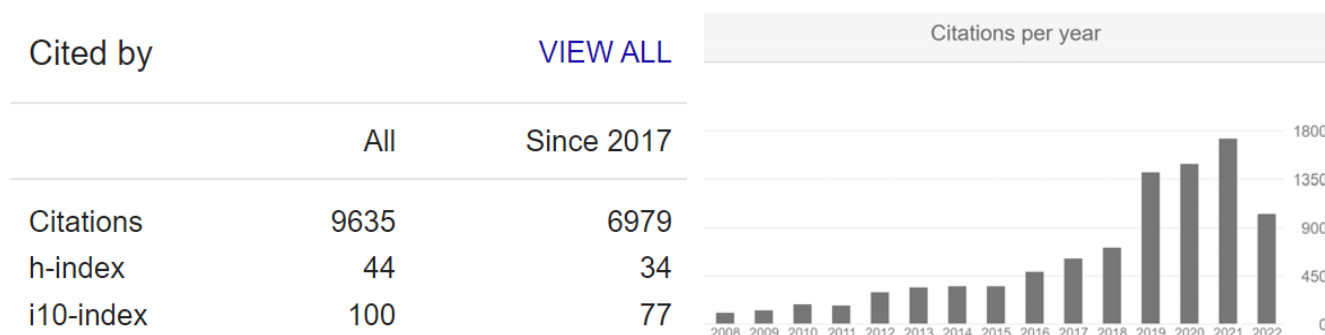
A list of publications with links to many of the manuscripts can be found at:

[http://aimlab.wpi.edu/people/Gregory\\_Fischer](http://aimlab.wpi.edu/people/Gregory_Fischer)

A citation index can be found at:

<https://scholar.google.com/citations?user=N00MU6AAAAAJ>

### **Citation Summary as of November 23, 2022 (via Google Scholar):**



The following list of accepted and published publications is sorted and numbered by category, and presented in reverse chronological order. Authors are classified as noted in the following legend.

**Legend** (for the following publication list):

- Ⓒ Denotes co-authors who are WPI graduate students
- ⒰ Denotes co-authors who are WPI undergraduate students
- Ⓕ Denotes co-authors who are other WPI faculty that collaborated on the work

### **Refereed Journal Articles**

1. Munawar A Ⓒ, Wu JY, Fischer GS, Taylor RH, Kazanzides P, *An Open Simulation Environment for Learning and Practice of Robot-Assisted Surgical Suturing*, IEEE Robotics and Automation Letters (RA-L), Vol 7, No 2, pp 3843-3850, April 2022.
2. Goldfarb NA Ⓒ, Lewis A Ⓒ, Tacescu A ⒰, Fischer GS, *Open source Vicon Toolkit for motion capture and Gait Analysis*, Elsevier Computer Methods and Programs in Biomedicine, Vol 212, pp 106414, Nov. 2021.
3. Gandomi KY Ⓒ, Carvalho PA Ⓒ, Tarasek M, Fiveland EW, Bhushan C, Williams E, Neubauer P, Zhao Z, Pilitsis JG, Yeo D, Nycz CJ Ⓕ, Burdette EC, Fischer GS, *Modeling of Interstitial Ultrasound Ablation for Continuous Applicator Rotation with MR Validation*, IEEE Transactions on Biomedical Engineering, Vol 68, No 6, pp 1838-1846, June 2021.
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5. Goldfarb NA <sup>©</sup>, Bales C <sup>©</sup>, Fischer GS, *Toward Generalization of Bipedal Gait Cycle During Stair Climbing Using Learning From Demonstration*, IEEE Transactions on Medical Robotics and Bionics, Vol 3, No 2, pp 446-454, May 2021.
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### **Conference Abstracts and Non Peer-Reviewed Papers**

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2. Gandomi KY , Carvalho PA , Zhao Z , Fischer GS, *Thermo-Acoustic Simulation of a Piezoelectric Transducer for Interstitial Thermal Ablation with MRTI Based Validation*, COMSOL Conference 2019, Boston, MA, USA, Oct 2019. (Best Paper Award)
3. Fiveland E, Tarasek M, Ghoshal G, Heffter T, Gandomi KY , Carvalho PA , Nycz CJ , Malette T, Campwala Z, Jeannotte W, Staudt M, Burdette EC, Fischer GS, Pilitsis JG, Yeo D, *MR imaging Evaluation of an Interstitial Focused Ultrasound Probe used in Robotically Assisted Brain Ablation Procedures*, Proceedings of the International Society for Magnetic Resonance in Medicine (ISMRM 2020), Oct 2020.
4. Gandomi KY , Nycz CJ , Carvalho PA , Zhao Z , Patel NA , Burdette EC, Fischer GS, *Development of a Real-Time Thermo-Acoustic Model for Interstitial Ultrasonic Conformal Ablation*, Focused Energy Delivery and Precision Intervention Workshop at Hamlyn Symposium, London, UK, June 2019.
5. Moreira P, Patel N , Wartenberg M , Li G , Heffter T, Burdette EC, Iordachita I, Fischer GS, Hata N, Tempny CM, Tokuda J, *Transperineal MR-Guided Prostate Biopsy: The Contribution of Needle Deflection to the Targeting Error*, International Symposium on Biomedical Imaging (ISBI 18) Washington, DC, April 2018.
6. Dickstein-Fischer LA, Crone-Todd DE, Chapman I, Fischer GS, *Do Social Robots Have a Place in the Practice of Applied Behavior Analysis?*, Association for Behavior Analysis International (ABAI), Paris, France, Nov 2017.
7. Nycz CJ , Delph MA , Keough K, Farrell T, Fischer GS, *Measuring Grip Forces in Activities of Daily Living with Relevance to Prosthetic and Orthotic Design*, Biomedical Engineering Society (BMES) Annual Meeting, Phoenix, AZ, Oct 2017.

8. Soderna BP , Nycz CJ , Fischer GS, *Measuring the Motion of Finger Joints during Natural Flexion and Extension of the Human Hand*, Biomedical Engineering Society (BMES) Annual Meeting, Phoenix, AZ, Oct 2017.
9. Fischer GS, Wartenberg M , Patel NA , Tokuda J, Tempny CM, Hata N, *Towards Cooperative Control of MRI-guided Pelvic Needle Placement Procedures*, 9th NCIGT Image Guided Therapy Workshop, Bethesda, MD, Mar 2017.
10. Suqui K , Strobel H , Nycz CJ , Fischer GS, Rolle MW, *Analysis of Structure and Strength of Tissue Rings Fabricated in Custom Machined Culture Wells*, BMES 2016 Annual Meeting, Minneapolis, MN, USA, Oct 2016.
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13. Levi K, Nycz C , Strobel H , Fischer GS, Rolle MW, *Custom Cell Seeding System to Enable Automated Vascular Tissue Self-Assembly*, Vascular Biology 2015: NAVBO Vascular Matrix Biology and Bioengineering Workshop, Hyannis, MA, USA, Oct. 2015.
14. Kesari A , Weaver S , Carvalho P , *Design Of A Robotic Assistive Device For Phlebotomy*, Biomedical Engineering Society (BMES) Annual Meeting, Tampa, FL, Oct 2015.
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18. Tokuda J, Fischer GS, Iordachita I, Tauscher S, Kazanzides P, von Tiesenhausen C, Burdette EC, Tempny CM, *Roles of OpenIGTLink in Medical Robotics Research*, Workshop on Shared Frameworks for Medical Robotics Research, International Conference on Robotics and Automation (ICRA 2015), Seattle, WA, USA, May 2015.
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24. Eslami S, Fischer GS, Tokuda J, Iordachita I, *Clinically Optimal Design and Development of an MRI-compatible Surgical Manipulator for the Prostate Percutaneous Intervention*, 9th Interventional MRI Symposium (iMRI), Boston, MA, USA, Sept 2012.
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37. Su H <sup>©</sup>, Harrington K <sup>©</sup>, Cole GA <sup>©</sup>, Wang Y <sup>©</sup>, Fischer GS, *Modular Needle Steering Driver for MRI-guided Transperineal Prostate Intervention*, IEEE International Conference on Robotics and Automation (ICRA), Workshop on Snakes, Worms and Catheters: Continuum and Serpentine Robots for Minimally Invasive Surgery, Anchorage, AK, May 2010.
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42. Tokuda J, DiMaio SP, Fischer GS, Csoma C, Gobbi D, Fichtinger G, Hata N, Tempany CM, *Real-time MR Imaging Controlled by Transperineal Needle Placement Device for MRI-guided Prostate Biopsy*, 16th Scientific Meeting and Exhibition of the International Society of Magnetic Resonance in Medicine (ISMRM 2008), May 2008.

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45. Fischer GS, DiMaio SP, Iordachita I, Fichtinger G, *Robotic Assistant for MR-guided Prostate Biopsy*, 6<sup>th</sup> Interventional MRI Symposium, Leipzig, Germany, Sept 2006.
46. Fischer GS, Deguet A, Csoma C, Taylor RH, Fayad LM, Carrino JA, Zinreich SJ, Fichtinger G, *Image Overlay for MR-Guided Joint Arthrography*, 6<sup>th</sup> Interventional MRI Symposium, Leipzig, Germany, pp 240-242, Sept 2006.
47. Fischer GS, Deguet A, Csoma C, Taylor RH, Fayad L, Zinreich SJ, and Fichtinger G, *MRI Image Overlay: Joint Arthrography Porcine Trials*, International Society for Magnetic Resonance in Medicine 14th Scientific Meeting (ISMRM 2006), Seattle, Washington, p 1735, May 2006.
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50. Fischer GS, Saha S, Horwat J, Yu J, Zand J, Marohn M, Talamini MA, Taylor RH, *An Intra-Operative System for Relating Ischemic Damage to Retraction Forces*, Annual fall meeting of the Biomedical Engineering Society (BMES 2005), Baltimore, MD, Sept 2005.
51. Zand JM, Fischer GS, Hanly E, Shih S, Marohn M, Taylor RH, Talamini MA, *Ischemia Sensing Surgical Instruments*, Annual congress of the Society of American Gastrointestinal Endoscopic Surgeons (SAGES 2005), Ft. Lauderdale, FL, April 2005.
52. DeOliviera M, Deguet A, Fischer GS, Balogh E, Taylor RH, Fayad LM, Zinreich SJ, Fichtinger G, *Image Overlay for CT-Guided Hepatic Needle Insertions - Cadaver Studies*, Congress of the Society of American Gastrointestinal Endoscopic Surgeons (SAGES 2005), Ft. Lauderdale, FL, April 2005.

### **Dissertations and Theses**

1. Doctoral Dissertation, Johns Hopkins University, *Enabling Technologies for MRI Guided Interventional Procedures*, 2008. <http://jhir.library.jhu.edu/handle/1774.2/33427>
2. Master's Thesis, Johns Hopkins University, *Electromagnetic Tracker Characterization and Optimal Tool Design - With Applications to ENT Surgery*, 2005. <http://jscholarship.library.jhu.edu/handle/1774.2/906>

## **Recent Presentations at Conferences, Seminars, Colloquia, etc.**

1. Panelist & Exhibitor at COVID-19 Challenge Finale & Celebration of the Mass. Digital Health Initiative, Somerville, MA, June 2022.
2. Speaker & Panelist for WPI Global Innovation for Impact Webinar, June 2022.
3. Speaker at Healthcare Robotics Engineering Forum. Talk Title: Robotic Technologies for In-situ MRI-Guided Interventions. Boston, MA, May 2022.
4. HealthTech Build Fireside Chat: *Surgical Innovations: AI & Emerging Technologies*, April 2022.
5. NeuroDiem Webinar Interview, March 2022.
6. Session Chair & Speaker at SBMT Annual Congress, Session on Neuro-Oncology: Image Guided Ablative Therapy. Talk title: Robotic Technologies for MRI-Guided Conformal Ablative Therapy, March 2022.
7. Speaker at National Center for Image-Guided Therapy (NCIGT) Leadership Meeting, Robotic Technologies for In-situ MRI-Guided Interventions, Feb 2022.
8. Panelist for WPI Innovation for Impact Event, Nov 2021.
9. Invited speaker for the Houston Methodist Hospital MIRIN XR Symposium: Exploring Extended Reality and Robotics, Sept 2021.
10. Invited speaker for the UW-sponsored Interactive Telerobotic Surgery Stakeholder Symposium, Speaking on Current State of the Technology for Telerobotic Healthcare, Jan 2021.
11. Invited speaker for the 18<sup>th</sup> Annual SBMT World Congress of Society for Brain Mapping and Therapeutics, July 2021.
12. BIOMED Device Meeting Panelist for Robotics Spotlight – How Research Efforts are Changing the Way Medtech Uses Robotics, Speaker on Closing the Loop in Image-Guided Robotic Surgical Interventions, Nov 2020.
13. ASME Webinar Speaker. Mechatronics – The Role of Mechanical Engineers in Robotic Surgery, Aug 2020.
14. AIM2020: Mechatronics for Infectious Diseases. Presenter on Emergency Use Medical Devices & Design Considerations, July 2020.
15. Speaker for the WPI Tech Old Timers Alumni Group, Medical Robotics Research @ WPI, March 2020.
16. Healthcare Robotics Engineering Forum. Panelist & presenter. Santa Clara, CA, Dec 2019.
17. International Symposium on Medical Robotics (ISMR) Workshop on Open Platforms for Medical Robotics Research. Co-organizer and speaker. Atlanta, GA, April 2019.
18. International Symposium on Medical Robotics (ISMR) Workshop on Building Software Systems for Image-Guided Robot-Assisted Interventions. Speaker. Atlanta, GA, April 2019.
19. Neurotech Investing & Partnering Conference, Speaker, Boston, MA, May 2019.

20. Hamlyn Symposium on Medical Robotics (HSMR), Demos and associated presentations, London, UK, June 2019.
21. The Robo-Healthcare Summit invited presentation on “Robotics and Automation: Eyes of the operating theatre: Image guidance for robotic surgery”, Boston, MA, October 2018.
22. Presentation on “Intelligent Active Assistive and Rehabilitative Soft Orthoses” at Delsys, Inc., Natick, MA, June 2018.
23. Presentation and Panel Participant for “Frontiers in Neurotechnology” Panel at Neurotech Investing & Partnering Conference, Boston, MA, May 2018.
24. Presentation and Panel Participant for “Sensors” Panel at UML/MassTech “Internet of Things (IOT) Forum: Enabling Technologies & Emerging Trends”, UMass Lowell, Lowell, MA, March 2018.
25. Presentation on "Medical Cyberphysical Systems" at Boston Scientific Corp., Marlborough, MA, December 2017.
26. ABAI presentation on "Do Social Robots Have a Place in the Practice of Applied Behavior Analysis?", Paris, France, November 2017.
27. Organizer of DVRK/Raven User Group Meeting and Presenter of "Infrastructure Update & Simulation Environments", University of British Columbia, Vancouver, BC, Canada, September 2017.
28. IROS Presentation on "Shared Platforms for Medical Robotics Research: Simulation Framework for Surgical Robots", Vancouver, BC, Canada, September 2017.
29. AUVSI Presentation and Panel Discussion, Newton, MA, June 2017.
30. The Robo-Healthcare Summit invited presentation on “Robotics and Automation: Eyes of the operating theatre: Image guidance for robotic surgery”, Boston, MA, June 2017.
31. MA Competitive Partnership Panel on Digital Health, Worcester, MA, May 2017.
32. GE Centricity Meeting, Hynes Convention Center, Boston, MA, May 2017.
33. LiveWorx Panel hosted by RoboticsTrends on “Improving Patient Care with Medical Robotics”, Boston Convention Center, Boston, MA, May 2017.
34. AUVSI NE Annual Meeting, keynote, "Healthcare Robotics Research @ WPI, Intro to PracticePoint", Worcester, MA, May 2017.
35. UK Delegation Meeting, Cambridge, MA, May 2017.
36. PracticePoint Kickoff, WPI, Worcester, MA, April 2017.
37. HRI '17 Presentation, Human Robot Interaction, Vienna Austria, March 2017.
38. TV Appearance on ABC with Mike Wankum, “Cute Penguin Robot Helping Kids with Autism Learn”, February 2017.

39. MasTech (MTC) Presentation on WPI's Mass Healthcare Technology Innovation Institute Initiative (HealthTech), November 2016.
40. TV Appearance on CBS with Dr. Mallika Marshall, "Penguin Robot Provides Help For Children With Autism", November 2016.
41. MasTLC Future of Robotics Summit at Microsoft, Medical Robotics Research, November 2016.
42. MassRobotics Robotics Interest Group at Vecna, Robotics in Medicine, March 2016.
43. NSRDEC, Presented at Collaborative Research Meeting, October 2016
44. AUVSI Robotica, Panelist and speaker for session on Surgical & Medical Robotics, June 2016.
45. Xconomy Robomadness at Google, Research demonstration, March 2016.
46. BWH Ferenc Jolez Research Seminar, Clinically-Focused Robotic Technologies for MRI-Guided Interventions, February 2016.
47. WPI Board of Trustees Meeting, "Research Overview: Medical Robotics & Computer-Integrated Surgery", November 2015.
48. WPI HDI Advisory Board meeting, "Healthcare Robotics: Rehabilitative and Assistive Robotics", November 2015.
49. Invited Colloquium Speaker at Dartmouth Jones Seminar, "Enabling Technologies for MRI-Guided Robotic Surgical Interventions", Dartmouth, NH, September 2015.
50. International Conference in Robotics and Automation, "Shared Frameworks for Medical Robotics Research: ROS in Medical Robotics", May 2015.
51. Society of Interventional Radiology, Image Guided Biopsy In The Era Of Personalized Cancer, Increasing Yield - Getting to the Target: "Role of Robotics-increasing the sampling area", May 2015.
52. SPIE Medical Imaging, "Combining Robots with Real-time Intra-operative MR Imaging to Enable Closed-Loop Interventions", February 2015.
53. Implementation of a Motion Planning Framework for the daVinci Surgical System Research Kit (dVRK), Hamlyn Symposium on Medical Robotics, London, United Kingdom, July 2014.

## **Honors, Awards, and Recognition Related to Scholarship**

- WPI Board of Trustees Award for Outstanding Research and Creative Scholarship (2021)
- PI for NIH Bioengineering Research Partnership, Physician Assistance Technology in Image-guided Robotic Intervention of Prostate: ~\$2.7M award (2021)
- Inducted as Senior Member of National Academy of Inventors (2019)
- Member of National Academy of Inventors (Inducted 2018)
- PI for Massachusetts Tech Collaborative PracticePoint Research Center – Accelerator for Healthcare Cyber-Physical Systems: \$5M award (2017)
- William Smith Foundation Dean’s Professor in Mechanical Engineering (2016)
- Co-PI for NSF National Robotics Initiative (NRI) award – Software Framework for Research in Semi-Autonomous Teleoperation: ~\$550k award (2016)
- PI for NIH Academia-Industry Partnership R01, MR-guided Precision Conformal Ablation Therapy for Brain Tumors: ~\$3M award (2013); Renewed for ~\$3M (2018)
- Mechanical Engineering Excellence in Research Award (2012 and 2013)
- WPI PI for NIH Bioengineering Research Partnership (BRP) through NCI – Enabling Technologies for MRI-Guided Prostate Interventions: ~\$1M award (2011)
- New Investigator Award for Congressionally Directed Medical Research Program (CDMRP) Prostate Cancer Research Program (PCRP): ~\$350k award (2009)

## **Grants and Fellowships**

***Bold*** indicates grant support to WPI where Dr. Fischer is a principal investigator (PI), WPI site PI, or project director (PD).

### **Awarded**

1. Role Co-PI: NIH Bioengineering Research Partnership, Physician Assistance Technology in Image-guided Robotic Intervention of Prostate
  - Source: US Federal Government, NIH NIBIB; Grant: R01 EB030539
  - MPls Fischer GS, Hata N (BWH)
  - WPI: ~\$1,400,000, (Aug 2021 – April 2025), Total Award: **\$2,674,512**
2. Role Co-I: NSF Future Manufacturing - FMNet: A Network for Rapid Execution for Scaling Production of Needed Designs (RESPOND)
  - Source: US Federal Government, NSF Grant: 2036917
  - PI Chen J (UML), Co-PIs Hart J (MIT), Reynolds E (MIT), Saberi S (WPI), Kirk C (MassTech)
  - Total Award: \$499,955 (Nov 2020 – Aug 2025)
3. Role Co-PI: WPI TRIAD - Photoacoustic Imaging of Neurovascular Bundles for Robot-Assisted Laparoscopic Pelvic Surgery
  - Source: Internal WPI Pilot
  - Co-PIs Fischer GS, Zhang H, Fichera L
  - Total Awards **\$60,000** (Jan 2020 – Dec 2021)
4. Role Co-PI/WPI PI: NSF AccelNet, Collaborative Research: AccelNet: International Collaboration to Accelerate Research in Robotic Surgery
  - Source: US Federal Government, NSF Grant: 1637759
  - Co-PIs Fischer GS, Kazanzides P (Johns Hopkins)
  - WPI Award: **\$593,706** (Sept 2019 – Aug 2024), Total Award: ~\$1,500,000
5. Role PI/PD: NIH Academia-Industry Partnerships to Translate and Validate In Vivo Cancer Imaging Systems R01 [Competitive Renewal], MR-guided Precision Conformal Ablation Therapy for Brain Tumors
  - Source: US Federal Government, NIH NCI; Grant: R01 CA166379
  - MPls Fischer GS, Pilitsis JG (Albany Medical Center); Co-Is Burdette EC (Acoustic MedSystems, Inc.), Yeo D (GE Global Research)
  - Total Award: **\$3,538,670** (Sept 2018 – Aug 2023)
6. Role Co-I (2<sup>nd</sup> Technical Lead): Advanced Regenerative Manufacturing Institute (ARMI) Biofab USA – Automated Coating of Cell Culture Surfaces with Growth Factor-Releasing Polyelectrolyte Multilayers
  - Source: US Federal Government, State Funding, and Corporate Match (Manufacturing USA)
  - PI Rolle M (WPI); Co-Is Peterson A (UML), Fischer GS; Corporate Partners Akron Biotech, Rooster Bio, Rockwell Automation

- Total project amount requested: \$1,442,698 / 2yrs , WPI project cost: \$586,286 (July 2018 – June 2022)
7. Role PI/PD (Collaborative effort): Massachusetts Technology Collaborative – MassTech, PracticePoint Research Center for Healthcare Cyberphysical Systems
    - Source: Commonwealth of Massachusetts, Grant: 17-1
    - PI/PD Fischer GS; Co-PIs Cyganski D (WPI), Sunak B (WPI), Venkatasubramanian K (WPI), Rundensteiner E (WPI)
    - Total Award: **\$5,000,000** from MA plus industry matching funds (June 2017 – May 2022)
  8. Role PI: Lufkin Foundation, Personalizing the Future of Healthcare Through In-situ 3D Printing
    - Source: Private Foundation
    - PI Fischer GS
    - Total Award: **\$100,000** (Jan 2018 – Dec 2018)
  9. Role Co-PI/WPI PI: NSF National Robotics Initiative – NRI, Software Framework for Research in Semi-Autonomous Teleoperation
    - Source: US Federal Government, NSF; Grant: 1637759
    - Co-PIs Fischer GS, Hannaford B (Univ. Washington), Taylor RH (Johns Hopkins), Kazanzides P (Johns Hopkins)
    - WPI Award: **\$550,157** (Oct 2016 – Sept 2020), Total Award: ~\$2,500,000
  10. Role WPI PI: Defense Health Program (DHP) Small Business Innovation Research (SBIR) Program with Liberating Technologies, Inc., Upper Limb Assistive and Rehabilitation Orthotic Device
    - Source: US Federal Government, DoD USAMRMC; Grant: W81XWH-15-C-0030
    - PI Farrell T (Liberating Technologies, Inc. – Lead Institution); Co-I Fischer, GS
    - WPI Subaward: **\$103,258** (Jan 2016 – Dec 2017)
  11. Role PI: Link Foundation Advanced Simulation and Training Fellowship, Interactive Training of Teleoperated Robotic System for Real-time MRI-guided Steerable Needle Intervention
    - Source: Private Foundation
    - PI Fischer GS; WPI Graduate Student Fellow Li G
    - Total Award: **\$28,000** (July 2014 – June 2015)
  12. Role PI/PD: NIH Academia-Industry Partnership R01, MR-guided Precision Conformal Ablation Therapy for Brain Tumors
    - Source: US Federal Government, NIH NCI; Grant: R01 CA166379
    - MPIs Fischer GS, Pilitsis JG (Albany Medical Center); Co-Is Gounis M (UMass Med), Ludwig R (WPI), Burdette EC (Acoustic MedSystems, Inc.)
    - Total Award: **\$3,002,141** (May 2013 – Aug 2018)
  13. Role Co-I/WPI PI: NIH Biomedical Research Partnership R01 Grant with Brigham and Women's Hospital, Enabling Technologies for MRI-Guided Prostate Interventions
    - Source: US Federal Government, NIH NCI, Grant: R01 CA111288

- MPIs Tempamy CM (Brigham & Women's Hospital – Lead Institution), Fichtinger G (Johns Hopkins), Burdette EC (Acoustic MedSystems, Inc.); Co-I Fischer GS, Hata N (Brigham & Women's Hospital)
  - WPI Subaward **\$947,058**, Total Award: \$4,390,339 (Sept 2011 – Aug 2016)
14. Role Co-I: NSF IGERT, Engineering Technologies for Translation of Biomedical Research – Training Innovative Leaders in Biofabrication
- Source: US Federal Government, NSF DGE; Grant: 1144804
  - PI Camesano T (WPI); Co-PIs Hoy F (WPI), Rolle M (WPI), Gaudette G (WPI), Billiar K (WPI), Chin K (WPI); Co-I and IGERT Advisor Fischer GS
  - Total Award: \$3,033,953 (July 2012 – June 2019)
15. Role PI: Link Foundation Advanced Simulation and Training Fellowship, Haptic Training and Interventional System for MRI-guided Percutaneous Needle Placement
- Source: Private Foundation
  - PI Fischer GS; WPI Graduate Student Fellow Su H
  - Total Award: **\$25,000** (July 2012 – June 2013)
16. Role PI: ASQ Biomedical Division Schlesinger Award Grant, Quantification of Robot-Assisted Needle Placement for MRI-guided Transperineal Prostate Interventions
- Source: Private Foundation
  - PI Fischer GS; WPI Graduate Student Co-I Su H
  - Total Award: **\$7,822** (Jan 2012 – Aug 2012)
17. Role WPI PI: Deshpande Program Award Grant, - Subcontract from MIT for MRI Robot Controller Development
- Source: Private Foundation
  - PI Walsh C (MIT – Lead Institution); WPI Subcontract PI Fischer GS
  - WPI Award: **\$12,500** (Sept 2011 – Jan 2012)
18. Role PI/PD: Peer-reviewed Congressionally Directed Medical Research Program (CDMRP) Prostate Cancer Research Program (PCRP) New Investigator Award Grant, Development of an MRI-Guided Intra-Prostatic Needle Placement System
- Source: US Federal Government, DoD USAMRMC; Grant: W81XWH-09-1-0191
  - PI Fischer GS
  - Total Award: **\$313,736** (July 2009 – June 2012)
19. Role PI: Peer-reviewed Congressionally Directed Medical Research Program (CDMRP) Fellowship – Prostate Cancer Research Program (PCRP) Graduate Training Fellowship, Robotic Prostate Biopsy in Closed MRI Scanner
- Source: US Federal Government, DoD USAMRMC; Grant: W81XWH-07-1-0171
  - PI Fischer GS; Advisor: Fichtinger G (Johns Hopkins)
  - Total Award: \$100,000 (January 2007 – January 2009) - Graduate fellowship prior to joining WPI

**NOTE:** Additional proposals are in review and in preparation, and are not listed here.

## **Patents**

### **Published Patents Granted and/or Pending (and associated patent families)**

1. Fichera L, O'Brien K, Boyer ZR, Broliar CT, Mart BG, Fischer GS, Stafford K, Carroll T, *Flexible articulating surgical probe*, US Application 16/817,280. [Status: US and International filings pending].  
<https://patents.google.com/patent/US20200289201A1/en>
2. Piecuch B, Kasvikis D, Genova P, Fischer GS, *Surgical Head Clamp and Robotics Platform*, Granted US Patent 10,182,879. [Status: US Patent Granted, Continuation pending, Licensed from WPI to AiM Medical Robotics]  
<https://patents.google.com/patent/US10182879B2/en>
3. Fischer GS, Su H, Dickstein-Fischer L, Harrington K, Alexander EV, *System and Method of Pervasive Developmental Disorder Interventions*, Granted US Patent 10,176,725, Priority 8/29/2011, Filed 8/29/2012. [Status: US Patent Granted, Continuation pending]  
<https://patents.google.com/patent/US10176725B2/en>
4. Fischer GS, Su H, *Apparatus and Methods for MRI-Compatible Haptic Interface*, US Application US20210093304. [Status: US and International filings pending, Licensed from WPI to AiM Medical Robotics]  
<https://patents.google.com/patent/US20210093304A1/en>
5. Fischer GS, Cole GA, Pilitsis JG, *System and Method for Robotics Surgical Intervention in a Magnetic Resonance Imager*, Granted US Patent 9,844,414. [Status: US Patent Granted, Continuation pending, licensed from WPI to AiM Medical Robotics]  
<https://patents.google.com/patent/US9844414B2/en>
6. Fischer GS, Su H, *System and Method for Underactuated Control of Insertion Path for Asymmetric Tip Needles*, Granted US Patents 10,052,458 & 11,207,500. [Status: US Patents Granted, Continuation and International filings pending, licensed from WPI to AiM Medical Robotics]  
<https://patents.google.com/patent/US10052458B2/en>
7. Nycz CJ, Albrecht EM, Chrobak M, Ghazi K, Fischer GS, Clark BA, *Clutch system for flexible endoscopes*, US Application US20220160207. [Status: US & International filings pending, contract work with Boston Scientific]  
<https://patents.google.com/patent/US20220160207A1/en>
8. Fischer GS, Carvalho PA, Zhao Z, Nycz CJ, *Optical Actuator*, PCT Application WO2020247481A2. [Status: US & International filings pending, licensed from WPI to AiM Medical Robotics]  
<https://patents.google.com/patent/WO2020247481A2/en>
9. Zand JM, Fischer GS, *Apparatus, Systems and Methods for Determining Tissue Oxygenation*, Granted US Patent 9,420,967. [Status: US Granted, International and US continuation pending, Developed with Surgisense Corp.]  
<https://patents.google.com/patent/US9420967B2/en>

10. Zand JM, Fischer GS, *Sensing Adjunct for Surgical Staplers*, Granted US Patent 8,118,206. [Status: US Granted, International and US continuation filings pending, Developed with Surgisense Corp.]  
<https://patents.google.com/patent/US8118206B2/en>
11. Zand JM, Fischer GS, *Surgical Instruments with Sensors for Detecting Tissue Properties, and System Using Such Instruments*, Granted US Patent 9,204,830. [Status: US Granted, China Granted, Other international filings and continuation pending, Developed with Surgisense Corp.]  
<https://patents.google.com/patent/US9204830B2/en>
12. Zand JM, Fischer GS, Knowles JT, *Apparatus, systems, and methods for mapping of tissue oxygenation*, US Application US20190282146. [Status: US and International filings pending, Developed with Surgisense Corp.]  
<https://patents.google.com/patent/US20190282146A1/en>

\*Additional recent filings not yet published.

## **Consulting Activities**

- Chief Science Advisor for AiM Medical Robotics, surgical robotics company
- Expert support to investment firms for due diligence of investment in healthcare robotics technology [clients confidential]
- Expert support in product liability case for wearable assistive healthcare technology [client confidential]
- Consulting on IP litigation strategy
- Expert for PTAB IPR proceedings. Provided expert declarations and deposition. In many cases supplemental declarations and associated depositions also provided.
  - o Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), DETATCHABLE MOTOR POWERED SURGICAL INSTRUMENT, U.S. Patent Nos.: 9,084,601, 8,998,058, 8,991,677. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), MOTOR DRIVEN SURGICAL CUTTING INSTRUMENT, U.S. Patent No.: 8,602,287. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: Ethicon Endo-Surgery, Inc. (Johnson & Johnson), ROBOTICALLY-CONTROLLED MOTORIZED SURGICAL END EFFECTOR SYSTEM WITH ROATARY ACTUATED CLOSURE SYSTEMS HAVING VARIABLE ACTUATION SPEEDS, U.S. Patent No.: 8,602,288. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: PTech, LLC, ROBOTIC SYSTEM FOR FASTENING LAYERS OF BODY TISSUE TOGETHER AND METHOD THEREOF, U.S. Patent No.: 10,368,953. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: PTech, LLC, ROBOTIC SYSTEM FOR ENGAGING A FASTENER WITH BODY TISSUE, U.S. Patent No.: 9,149,281. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: PTech, LLC, ROBOTIC FASTENING SYSTEM, U.S. Patent No.: 9,192,395. Engaged by Fish & Richardson P.C. on behalf of Intuitive Surgical, Inc. (Petitioner)
  - o Assignee: Teladoc Health, Inc., ROBOTIC BASED HEALTH CARE SYSTEM, U.S. Patent Nos.: 8,179,418, 10,471,588. Engaged by Fish & Richardson P.C. on behalf of American Well Corporation (Petitioner)
  - o Assignee: Teladoc Health, Inc., DOCUMENTATION THROUGH A REMOTE PRESENCE ROBOT, U.S. Patent No.: 8,849,680. Engaged by Fish & Richardson P.C. on behalf of American Well Corporation (Petitioner)
  - o Assignee: Teladoc Health, Inc., REMOTE PRESENCE DISPLAY THROUGH REMOTELY CONTROLLED ROBOT, U.S. Patent No.: 7,761,185. Engaged by Fish & Richardson P.C. on behalf of American Well Corporation (Petitioner)