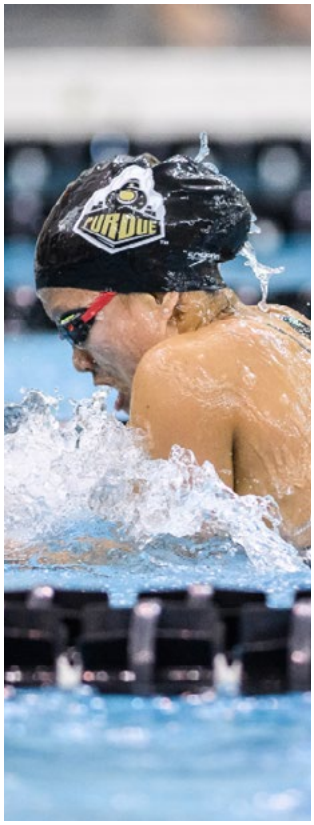
CONFERENCE PROGRAM





PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

June 6 - 9, 2022
Purdue University
West Lafayette, Indiana, USA

INDEX

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

WELCOME!

Welcome to the *Engineering of Sport 14*, the bi-annual conference of the International Sports Engineering Association (ISEA). The conference organizing committee and the Ray Ewry Sports Engineering Center are honored and pleased to have you here at Purdue University. This is the first time an NCAA Division 1 Power 5 school (ACC, Big Ten, Big 12, Pac-12, SEC) has had the privilege of hosting this conference, and we hope to share why that makes this year's conference unique throughout the week.

The Ray Ewry Sports Engineering Center (RESEC) was launched as a collaboration between Purdue's College of Engineering and Intercollegiate Athletics Department, capitalizing on Purdue's reputation as the Cradle of Quarterbacks and Astronauts. RESEC provides focus and energy to the ground-breaking research happening across Purdue that can impact athletic performance, athlete health and safety, and the fan's experience through the optimization of data science and sports engineering.

This conference is intended to bring the sports engineering community together to showcase the cutting-edge research being done in sports; highlight how industry, research, and athletes are working together to advance all areas of sport; and engage everyone in conversations about the current and future state of research and the sports engineering industry. A lot has changed in the last few years, including how data is used to optimize athlete performance and how fans consume sport, and we hope that this week sparks new ideas and collaborations, challenges you to see new perspectives, and strengthens our sports engineering community.

Organizing a fully in-person conference after a pandemic had its challenges but was made possible by the support from Wilson Sporting Goods, Indy Eleven, Specialized, adidas, ISEA, Sports Engineering Journal, Purdue College of Engineering, Purdue Athletics, and the attendees. Thank you for helping us bring this exciting event to life!

The Conference Hosts

Jan-Anders Mansson, Anna Giesler, and Kim Blair

IMPORTANT INFORMATION

To contact the conference organization

During the conference, we have volunteers in team shirts who are available to assist you with any questions you might have. If no one is available, please call Jan-Anders Mansson at +1 (765) 491-0469 or Anna Giesler at +1 (616) 928-4563.

In the case of a medical emergency, call 911

Wi-Fi:

There are two available options:

1. AT&T Guest Network – this is the publicly accessible guest network. Join the 'attwifi' network and follow the prompts.

2. Eduroam – this is available to academics/students whose university is a member of the eduroam network. Sign in using your university credentials.

Helpful Addresses:

Union Hotel
201 S Grant Street,
West Lafayette, IN 47906
+1 (765) 494-8922

Conference Venue (Shivley Club)
850 Steven Beering Drive,
West Lafayette, IN 47906
+1 (765) 494-9542

Harry's Chocolate Shop
329 W State St,
West Lafayette, IN 47906

Memorial Mall
Oval Dr, West Lafayette, IN 47906

Baseball Game -- Loeb Stadium
1915 Scott St, Lafayette, IN 47904

For assistance with questions related to the evening social events, contact Anna Giesler at +1 (616) 928-4563.

Ray Ewry Sports Engineering Center

The RESEC provides focus and energy to the ground-breaking research happening across Purdue that can impact athletic performance, athlete safety, fan experience through the optimization of data science and sports engineering.

RESEARCH

The Ray Ewry Sports Engineering Center (RESEC) was launched as a joint collaboration between Purdue College of Engineering and Purdue Intercollegiate Athletics, highlighting Purdue's reputation as the Cradle of Quarterbacks and Astronauts. We collaborate closely with partners in athletics, industry, academia, and more to create the solutions that will help bring sports into the future, specifically in three key areas:

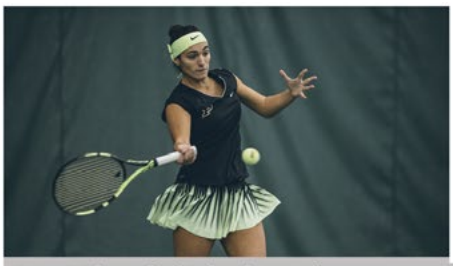
- **Smart Performance & Fan Experience**
- **Injury Reduction & Rehabilitation**
- **Sports Integrity, Fairness, & Societal Integration**

Visit our website:
https://engineering.purdue.edu/Engr/Ewry

FOCUS AREAS


Digitally Enhanced Athlete and Fan Experience


Digital-based Sports Execution System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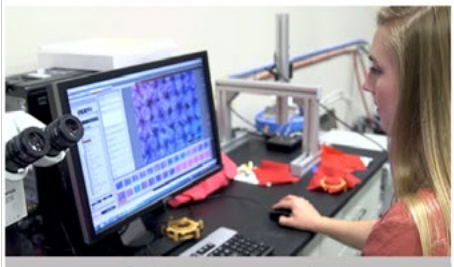
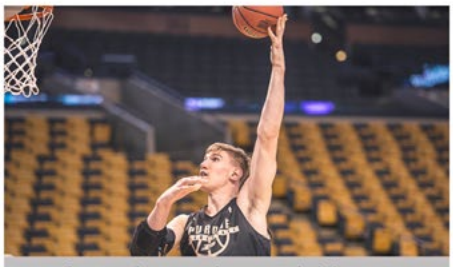
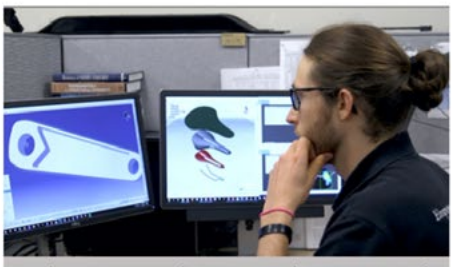
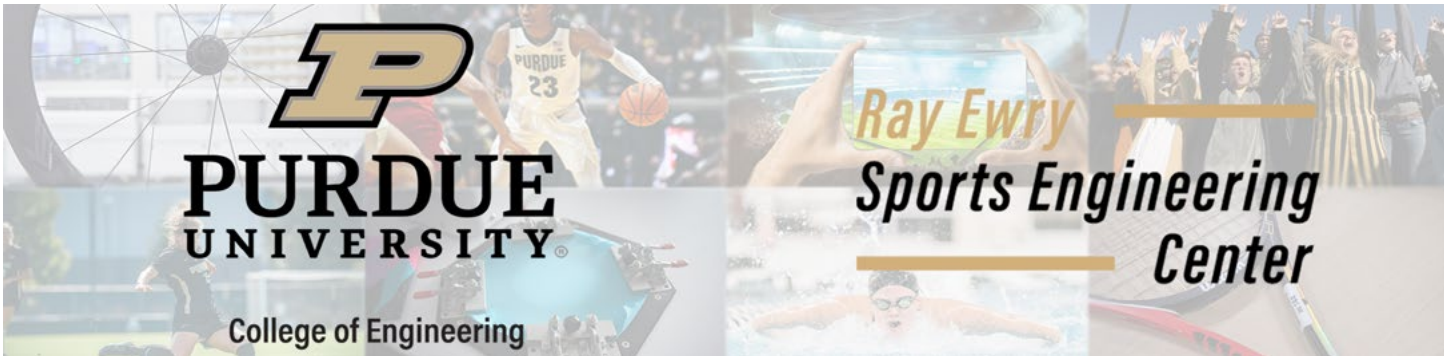

Smart Materials for Performance and Safety


Design for Prosthetics and Injury Rehabilitation


Simulation Integrated Prototyping (Promtotyping™)



Smart Performance and Fan Experience

Sensor-based technology is an expanding opportunity to make athletes more competitive while enhancing fan experience. RESEC is developing novel sensor-integrated sports equipment to help athletes and coaches improve performance and training.

Smart stadium technology offers opportunities for enhancing fan engagement. The RESEC team is developing low-risk, high-return methods for increasing fan engagement and enhancing overall viewer excitement.

Injury Reduction and Advanced Rehabilitation

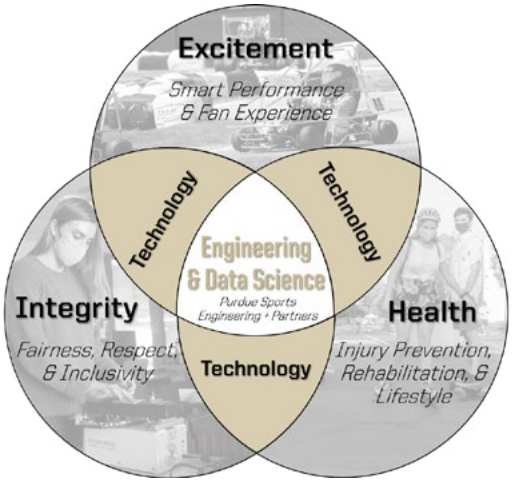
RESEC's commitment to injury reduction and advanced rehabilitation is as a valuable recruitment tool as Purdue continues to draw the most competitive student-athletes in the nation.

By working in areas such as the advancement of non-invasive lactate level testing, the evaluation of protective equipment, and the design of safer playing surfaces, the RESEC is pioneering the next generation of sport.

Sports Integrity, Fairness, and Social Integration

As every athlete knows, sports are far more than just physical activity– they build self-esteem, stimulate mental and emotional growth, relieve stress, and enhance a person's sense of accomplishment and social well-being.

But in order to reap these benefits, it's critical that a level playing field is maintained. Significant new research addresses issues in the merging interfaces of sports integrity, fairness, and social integration.



Engineering and data science are at the center of excitement, health and safety, and the integrity of sport, and by bringing a **data-driven, human-centered** approach to this industry, we can address the growing need and desire to increase participation and engagement of athletes and fans.

NEW EDUCATION

NEW: Professional Master's in Sports Engineering

Starting Fall 2022, students have the opportunity to specialize their studies in sports engineering. Our goal is to equip the next leaders in this field with the sills and tools needed to be successful .

https://engineering.purdue.edu/sports-engineer-

Program Highlights

- One-year residential program: All courses are in-person on the West Lafayette campus.
- Holistic and well-rounded approach that combines engineering, business, and digital technologies.
- Engages students with industry, academia, and sports federations.

Conference Agenda

Monday June 6, 2022			
7:30	**Check-in, Breakfast, Networking**		
8:00	**Opening Remarks**		
8:30	**Keynote Presentation – "Technology The Games Enabler" John Paul Giancarlo, IOC**		
Session 1: Equipment and Apparels for Performance			
Number	**Start**	**Title**	**Authors**
6	09:15	Comparing the friction of tennis shoes	John Hale, Roger Lewis and Matt Carre
8	09:30	Morphometric analysis to determine how the shape of tennis rackets has developed	Tom Allen, Luca Taraborelli and Robyn Grant
40	09:45	A novel recycling approach for more sustainable sport equipment	Martino Colonna, Lorenzo Crosetta, Alessandro Nanni, Mariafederica Parisi, Alessandro Speranzoni and Giuseppe la Fauci
10:00	**Poster Session and Networking Break**		
Session 2: Equipment and Apparels for Performance			
Number	**Start**	**Title**	**Authors**
21	10:30	Effect of additively manufactured padding on the mechanical and thermal comfort of MTB-backpacks	Frank I. Michel, Stefanie Zelt, Dominik Krumm, Andreas Knöchel and Stefan Schwanitz
78	10:45	Characterising the foot pads of climbing mammals to inspire new climbing shoe designs	Stephen Spurrier, Robyn Grant and Thomas Allen
37	11:00	Sports equipment design impact on athlete performance – The PR1 Paralympic women's indoor rowing world record	Sindre Wold Eikevåg, Jørgen Falck Erichsen and Martin Steinert
86	11:15	Monitoring balance in rowing using a modified dynamic ergometer	Matthew T. O. Worsey, Regina Arias, David V. Thiel, Jonathan Shepherd, Allan Hahn and Hugo G. Espinosa
113	11:30	Effect of fabric reinforcement on the flexural properties of EPS-Core surfboard constructions	Sam Crameri, Filip Stojcevski and Clara Usma-Mansfield
76	11:45	Simulation on different sail wing pumping amplitudes for propulsion performance in upwind condition	Lin Shijie, Zheng Weitao and Ma Yong
12:00	**Lunch**		
13:00	**Sports Engineering Journal Open Session**		
Session 3: Equipment and Apparels for Performance			
Number	**Start**	**Title**	**Authors**
107	13:30	Hardness of wood baseball bats	Blake Campshure, Paul Lancisi, Patrick Drane and James Sherwood
85	13:45	An instrumented thumb slug for determining a bowling ball's axis of rotation	Owen Boyer, Animesh Shukla and James Chagdes
39	14:00	On-site aerodynamic investigation of speed skating	Alexander Spoelstra, Wouter Terra and Andrea Sciacchitano

27	14:15	The effect of split hook design on the deformation of splitboards	Philippe Gosselin, Jonas Truong and Alexis Lussier-Desbiens
29	14:30	The effect of bending and torsional stiffness on the edge grip of an alpine ski	Jonas Truong, Philippe Gosselin and Alexis Lussier Desbiens Alexis Lussier Desbiens
	14:45	**Poster Session and Networking Break**	
Session 4: Equipment and Apparels for Performance			
Number	**Start**	**Title**	**Authors**
18	15:15	Extraction of differences in deformation behavior of shafts with different kick points	Kosuke Okazaki, Nobutaka Tsujiuchi, Akihito Ito, Kosuke Ito and Masahiko Ueda
96	15:30	Effects of golf ball dimple surface occupancy, volume ratio and depth on aerodynamic characteristics during rotation	Kohei Moriyama and Hiroo Okanaga
65	15:45	Comparison of three-dimensional dynamic models for golf clubhead-ball impacts	Adam Caldwell and John McPhee
12	16:00	Influence of putter shaft offset on performance	Sasho MacKenzie, Luke Kell, Daniel Ura and Erik Henrikson
32	16:15	The effect of club length, face bulge radius, and center of gravity depth on optimal golf drives -- a simulation study	Spencer Ferguson, William McNally and John McPhee
95	16:30	Constant parameter visco-elastic model of a normal incidence football impact	Katie Mills, Johsan Billingham, Simon Choppin, Simon Goodwill and Marcus Dunn
126	16:45	Development and validation of a hyper-elastic, finite element soccer ball model	Megan Barnes-Wood, Matt Stewart, Hugh McCloskey and Peter Theobald

Tuesday June 7, 2022			
7:30		**Check-in, Breakfast, Networking**	
Session 5: Digitally enhancing Technologies			
Number	**Start**	**Title**	**Authors**
5	08:00	Torque-to-spin efficiency of pitches analysed with a smart baseball	Franz Konstantin Fuss, Batdelger Doljin, Jeong Kwangyul and Young-Kwan Kim
125	08:15	Measuring bat-ball impact location using accelerometers	Bin Lyu and Lloyd Smith
66	08:30	The "sweet spot" of a driver by measures of post-impact clubhead rotation	Paul Lückemann, Jonathan R. Roberts, Steph Forrester, Aimée Mears and Jonathan Shepherd
69	08:45	Analysis of golf swings of varying skill level using singular value decomposition	Kenta Matsumoto, Nobutaka Tsujiuchi, Akihito Ito, Hiroshi Kobayashi, Masahiko Ueda and Kosuke Okazaki
31	09:00	Predicting the flight of a golf ball: comparing a physics-based aerodynamic model to a neural network	Spencer Ferguson, William McNally and John McPhee
9:15		**Keynote Presentation – "Simulate human body mechanics considering environment and even intention", Prof. Motomu Nakashima, Tokyo Institute of Technology and ISEA Fellow**	
10:00		**Poster Session and Networking Break**	
Session 6: Digitally enhancing Technologies			
Number	**Start**	**Title**	**Authors**
55	10:30	A change of angular momentum during the approach phase into the curved path in sprint running	Tatsuro Ishidzuka, Yuji Ohgi, Sam Gleadhill, Ryu Nagahara and Tomohito Wada
108	10:45	The agreement between wearable sensors and force plates for the analysis of stride time	Patrick Slattery, Luis Eduardo Cofré Lizama, Jon Wheat, Paul Gastin, Ben Dascombe and Kane Middleton
104	11:00	Wearable chest sensor for running stride and respiration detection	Severin Bernhart, Eric Harbour, Ulf Jensen and Thomas Finkenzeller
67	11:15	Automatic classification of take-off type in figure skating jumps using a wearable sensor	Michael Jones, Sarah Ridge, Mia Caminita, Kirk E. Bassett and Dustin Bruening
13	11:30	Body-attached sensors for automatic detection of skating stroke events in speed skating	Dominik Krumm, Jens Buder and Stephan Odenwald
53	11:45	Validity of Instrumented medicine ball measurements	Aaron Trunt, Cody Reed and Lisa MacFadden
12:00		**Lunch**	
13:00		**Keynote Presentation — "The Role of Research on Football's Global Stage", Johsan Billingham, FIFA**	

Session 7: Digitally enhancing Technologies			
Number	**Start**	**Title**	**Authors**
70	13:45	The potential of co-simulation in sports engineering – a review on spine simulations	Kati Nispel
124	14:00	Effect of extreme conditions on athlete performance	Anup Paul and Keith Hanna
48	14:15	Application of video interpolation to markerless movement analysis	Marcus Dunn, Adam Kennerley, Kate Webster, Kane Middleton and Jon Wheat
22	14:30	Disc golf trajectory modelling combining computational fluid dynamics and rigid body dynamics	Knut Erik Teigen Giljarhus
14	14:45	Effect of silhouette accuracy on visual hull quality	Guido Ascenso, Thomas Allen, Moi Hoon Yap, Carl Payton and Simon Choppin
	15:00	**Poster Session and Networking Break**	
Session 8: Data Science and Security			
Number	**Start**	**Title**	**Authors**
10	15:30	A Fuzzy controller design for a mechatronic ski binding	Aljoscha Hermann, Dirk Baumeister, Patrick Carqueville and Veit Senner
68	15:45	A simple and objective way to categorise alpine skis	Jonathan Audet, Abdelghani Benghanem and Alexis Lussier-Desbiens
49	16:00	Analysis and reconstruction of head kinematics during accidents in fast alpine skiing disciplines	Nicolò Dall'Acqua, Jonas Willén, Johan Weman, Philip Malmegård and Nicola Petrone
16	16:15	Real-time on-water Estimation of a sprint canoe paddle path	Sam Heavenrich and Stephen Tullis
52	16:30	Equestrian helmet performance in crush scenarios	Jasmin Stoff, Rhosslyn Adams, Benjamin Hanna, Helen Riley and Peter Theobald
116	16:45	Use of instrumented mouthguards for rugby collisions quantification: a preliminary study on elite players	Max Petetin, Laura Valdes-Tamayo, Thomas Provot, Antoine Kneblewski, Olivier Rouillon, Philippe Rouch and Maxime Bourgain

Wednesday June 8, 2022			
7:30	**Check-in, Breakfast, Networking**		
Session 9: Equipment and Apparels for Safety			
Number	**Start**	**Title**	**Authors**
2	08:00	Fabrication of auxetic foam in a pressure vessel for sports applications	Olly Duncan, Gemma Leslie, Stephen Moyle, David Sawtell and Tom Allen
3	08:15	A methodology for observing the deformation of rubber studs when stepping on a stone	Robin Compeyron, Jürgen Mitternacht, Veit Senner, Bahador Keshvari and Valentin Wohlgut
9	08:30	Development of a studded outsole with the help of Artificial Neural Networks (ANN)	Bahador Keshvari, Long Lehoang and Veit Senner
62	08:45	Influence of impact location on performance of rock climbing helmets	Mark Begonia, Bethany Rowson, Blake Scicli and John Eric Goff
71	09:00	Free-fall drop test rig to replicate head impacts in ice hockey	Daniel Matthias Haid, Leon Foster, John Hart and Oliver Duncan
9:15	**Keynote Presentation — "Human Experience of Performance", Tom Waller, adidas**		
10:00	**Poster Session and Networking Break**		
Session 10: Equipment and Apparels for Safety			
Number	**Start**	**Title**	**Authors**
58	10:30	Implementing an ISO standard for snowboarding wrist protectors	Caroline Adams, Thomas Allen, Othmar Brugger, Heather Driscoll, Peter Gyger, Nick Hamilton, David James, Gemma Leslie, Chloe Newton-Mann and Keith Winwood
35	10:45	Repeatability of a bend test For measuring the stiffness of snowboarding wrist protectors	Gemma Leslie, Tom Allen, Keith Winwood, Weizhuo Wang and Nick Hamilton
36	11:00	The external and internal geometries of rugby union players' shoulder complex	Angus Hughes, Heather Driscoll and Matt J. Carre
50	11:15	Validation of a finite element model of a shoulder surrogate for accessing paddings in rugby union	Syed Adil Imam, Heather Driscoll, Keith Winwood, Praburaj Venkatraman and Tom Allen
34	11:30	Assessing the ability of padded clothing to prevent stud induced injuries in rugby union	Angus Hughes, Heather Driscoll, Syed Iman, Tom Allen and Matt J. Carre
19	11:45	Minimising skin injuries on rugby turf	Max MacFarlane, Chris Dyson, Marc Douglas and Peter Theobald
12:00	**Lunch**		
13:00	**Panel Session — "Forging a Career in Sports Engineering - How to Find Your Personal Path" (ISEA)**		

Session 11: Coaching and Safety			
Number	**Start**	**Title**	**Authors**
112	14:00	When and why do children make decisions about STEM careers and opportunities for sports engineering?	Charlene Willis, Daniel James, Jeff Parker and James Lee
43	14:15	Lessons learned in the Alliance for Sports Engineering Education (A4SEE), an Erasmus+ project	Arjen J. Jansen, Anoek van Vlaardingen, Simon Choppin, John Hart, Stefan Litzenberger, Stefan Schwanitz, Mark de Zee and Pascal Madeleine
89	14:30	Is there a need to rethink heading training in soccer?	David Rowlands, Matthew Worsey, Hugo Espinosa, Will Sutton, Rajtilak Kapoor, Felix Leung, Dilani Mendis, Brittany Grantham, Julie Hides and David Thiel
127	14:45	Increasing helmet friction as a novel avenue to achieving enhanced head health	Scott Townsend and Peter Theobald
	15:00	**Poster Session and Networking Break**	
Session 12: Coaching and Safety			
57	15:30	Instrumentation of sprint and long jump tracks of an indoor athletics field to study athletes' performances	Paolo Mistretta, Mattia Scapinello, Samira Breban, Andrea Giovanni Cutti and Nicola Petrone
74	15:45	Analysis of wheelchair sprint biomechanics on two elite athletes on an instrumented drum ergometer	Francesco Bettella, Biagio Beneduce, Mario Poletti and Nicola Petrone
56	16:00	Torsion loads on a ski-touring boot sole during uphill climbing and downhill skiing	Giuseppe Zullo, Pierluigi Cibin and Nicola Petrone
23	16:15	Development of a test concept for investigating the false release of alpine touring ski bindings	Raphael Fischer, Stefan Schwanitz, Manuel Aumann and Stephan Odenwald
94	16:30	An examination of the relationships between curling rock rotational and linear velocities, and resulting displacements, at low throwing speeds	Amir Ravanbod, Sean Maw and Eugene Hritzuk

Thursday June 9, 2022			
7:30	**Check-in, Breakfast, Networking**		
Session 13: Cycling Technologies for Virtual and Live Events			
Number	**Start**	**Title**	**Authors**
38	08:00	Data-driven evaluation of road cycling courses	Steven Verstockt and Jelle De Bock
17	08:15	Parameter-space mining of 2018-2020 Tours de France to model 2021 Tour de France	Noah Baumgartner and John Goff
26	08:30	Aerodynamical benefits by optimizing cycling posture	Silas Koehn, Luca Oggiano, Kai Schaffarczyk and Alois Peter Schaffarczyk
46	08:45	Automatic summarization of cyclocross races	Jelle De Bock and Steven Verstockt
09:00	**Keynote Presentation — "The Importance of Engineering in Sport", Michael Rogers, UCI**		
122	09:45	Smart trainer homologation system	Teal Dowd, Justin Miller, Diana Heflin, Wim Sweldens, Andrei Krasilnikau and Jan-Anders Mansson
123	10:00	Homologation and certification approach for smart bike trainers	Diana Heflin, Justin Miller, Teal Dowd, Michael Rogers and Jan-Anders Mansson
10:15	**Poster Session and Networking Break**		
Session 14: Cycling Technologies for Virtual and Live Events			
Number	**Start**	**Title**	**Authors**
119	10:45	Cycling and sustainability: development of a Recycled Carbon Fiber (rCF) crankset demonstrator	Morgan Chamberlain, Justin Miller, Diana Heflin, Teal Dowd, Jung Soo Rhim, Ilke Akturk, Jacob Coffing and Jan-Anders Mansson
30	11:00	Heat transfer numerical simulations for bicycle disc brakes	Ioan Feier
60	11:15	Vibrational analysis of a flexible bicycle stem during indoor in-vivo cycling on a two rollers servohydraulic test bench	Mattia Scapinello, Enrico Girlanda and Nicola Petrone
115	11:30	Preliminary design of a novel smart glove with capacitive pressure sensors for force grip analysis in cycling	Teodorico Caporaso, Paolo Bellitti, Stanislao Grazioso, Mauro Serpelloni, Emilio Sardini and Antonio Lanzotti
12:00	**Lunch**		
13:00	**Panel Session: "The Future of Sports? Merging the Digital and Physical" (moderated by Stacey Burr)**		
Session 15: Equipment and Apparels			
Number	**Start**	**Title**	**Authors**
73	14:00	Angular rate effect on stiffness and damping characteristics of different head/neck assemblies during cyclic tests	Marco Rango, Giuseppe Zullo, Leonardo Marin, Andrey Koptyug and Nicola Petrone
61	14:15	A novel framework for design-property decision-making in polymer lattices when controlling for printed mass	Ana Paula Clares, Guha Manogharan, Landon Thomas and David Krzeminski

99	14:30	The effect of pressure and kick speed on soccer ball performance	Praveen Kumar Sharma and Lloyd Smith
87	14:45	Improvement of the training paddle for a swimmer with unilateral transradial deficiency	Motomu Nakashima and Yohei Chida
	15:00	**Poster Session and Networking Break**	
Session 16: Equipment and Apparels			
Number	**Start**	**Title**	**Authors**
83	15:30	Variability in rotational traction testing of artificial surfaces.	Harry McGowan, Paul Fleming, Steph Forrester and David James
100	15:45	Body-attached sensor nodes for automatic detection of hike events and parameters	Giuseppe Sanseverino, Dominik Krumm, Wolfgang Kilian and Stephan Odenwald
121	16:15	Measuring shuttlecock drag in free flight	Achyut Paudel and Lloyd Smith
75	16:30	Effect of temperature on the vertical deformation performance of polyurethane athletics track	Liu Gan, Zheng Weitao, Wang Hong, Meng Yanrong and Han Rui

POSTER SESSIONS		
Monday June 6 – Thursday June 9		
Number	**Title**	**Authors**
11	BASAS: a graphical tool to investigate variability, repeatability and asymmetries in squat	Mattia Stival, Leonardo Bidogia and Alessandro Volpe
25	Mechanical simulation for testing the forefoot cushioning of running shoes	Dominik Krumm, Stefan Schwanitz and Stephan Odenwald
28	Development of a ski testing machine based on the effective friction coefficient for classic cross- country skis	Alexis Dumas, André Bégin-Drolet and Julien Lépine
33	Deep Learning Model for Integrated Estimation of Wheelchair and Human Poses Using Camera Images	Shimpei Aihara, Takara Sakai, Ryusei Shibata, Toshiaki Matsubara, Ryosuke Mizukami, Yudai Yoshida and Akira Shionoya
41	Carbon composite plates for running shoes: a novel testing method for the measure of flexural stiffness, rebound and damping	Martino Colonna, Lorenzo Crosetta, Alessandro Nanni, Daniel Colombo and Tommaso Maria Brugo
42	Aerodynamic Characteristics of the Badminton Shuttlecock Shortly After Smash	Nor Nadhirah Binti Md Zaharil and Hiroo Okanaga
44	Extraction of running stance phase using tibial acceleration	Xu Zhang, Laura Valdes-Tamayo, Maxime Bourgain, Delphine Chadefaux and Thomas Provot
47	Towards Quantifying Movements in Qigong	Melanie Baldinger, Patrick Carqueville, Thomas Geier, Christian Schuster, Jiexiang Shu, Aljoscha Hermann and Veit Senner
54	Development of Mediolateral Ground Reaction Force across different Running Speeds to maintain a straight running path in Transfemoral Amputees	Ying Wai Tang, Akihiko Murai and Hiroaki Hobara
59	Measuring Skiing Speed – Possibilities of Machine Learning	Patrick Carqueville, Aljoscha Hermann and Veit Senner
63	Development and Testing of an Additively Manufactured Customizable Golf Club	Ken Nsiempba, Adam Caldwell, Spencer Ferguson, Michael Lenover, Mizan Abu Ramadan, William Tranchemontagne, Sanjeev Bedi, John McPhee and Ehsan Toyserkani
77	Electromyograph Estimation of Wheelchair Operators Using Deep Learning	Shimpei Aihara, Ryusei Shibata, Ryosuke Mizukami, Takara Sakai and Akira Shionoya
80	Transition of iEMG for During Straight-line Driving with One-handed Handrim Operation	Satoshi Ohashi, Akira Shionoya, Masahito Nagamori and Hisashi Uchiyama
81	Analysis of Kinetic and kinematic data from instrumented outrigger-skis of an elite Paralympic alpine skier: a pilot study	Sindre Wold Eikevåg, Harald Grøndahl, Henrik Sletten, Helene Silseth and Martin Steinert
84	Sports Engineering vs Sports Innovation	Arjen J Jansen
90	STEM educational engagement through coopetition, sport and wearable technology	Daniel James, James Lee, Yuji Ohgi, Charlene Willis, Nicola Petrone, Brendon Ferrier, Tomohito Wada, Mohammad Al-Rawi and Jeff Parker

92	Development of a Remote Wearables Laboratory Course	Patrick Mayerhofer, James Carter and Max Donelan
98	Effect of modular sports flooring on static and dynamic friction of common sport shoes	Nicholas Busuttil, Marcus Dunn, John Hale, Alexandra Roberts and Kane Middleton
103	Early Life Benefits of Hybrid Sports Turf	Paul Fleming, Lewis Darwin and Steph Forrester
106	The Permeability and Performance of Competition Swimsuits	Hannah DeBoer

SOCIAL EVENTS

Monday, June 06

Join us at the iconic Purdue bar, Harry's Chocolate Shop, for a casual social event. Catch up with old friends and make some new ones!

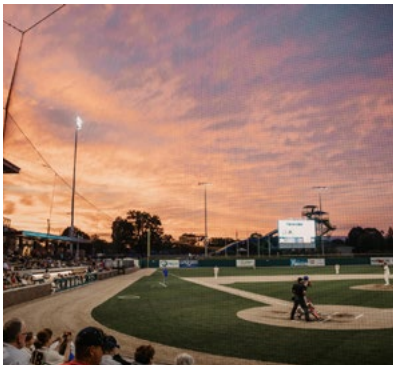
Time: 18:30-21:30
Location: 329 W State St, West Lafayette, IN
Directions

Tuesday, June 07

ISEA Members Picnic! Grab your dinner and bring it to Memorial Mall for a picnic and yard games. This will be a fun evening to reconnect with the ISEA community.

Time: 18:30
Location: Oval Drive, West Lafayette, IN 47906)
Directions

Wednesday, June 08



The Lafayette Aviators baseball team takes to the pitch for a night at the ballpark, sponsored by Wilson. Food and non-alcoholic beverages provided. Buses leave from the Union Hotel at **18:15** and **18:45**. and will return at the end of the game. Tickets available on a first come, first served basis at the check-in table Wednesday.

Time: First pitch at 19:00
Location: 1915 Scott St, Lafayette, IN 47904
Directions

SOCIAL EVENTS

Thursday, June 09

To wrap up the week, we'll celebrate with a gala dinner, featuring the awards ceremony and an invited speaker. A cocktail hour will start after presentations conclude for the day, with dinner following at 18:00.

Time: 18:00
Location: Conference venue

TOURS & OTHER ACTIVITIES

What is RESEC?

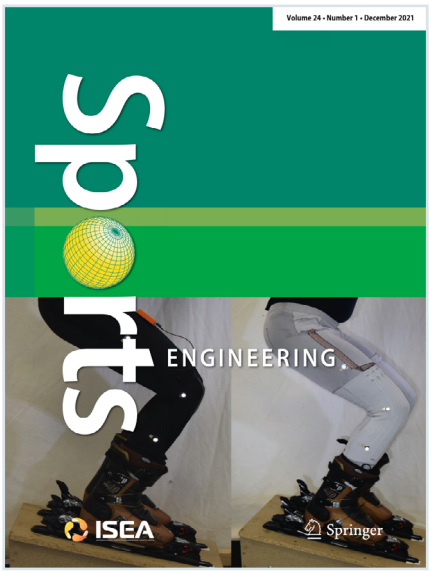
Wednesday June 8 during lunch, there will be a brief presentation on the Ray Ewry Sports Engineering Center and what they do.

Athletics facilities tour

Thursday June 9 at 11:55, there will be a tour of the athletics facilities. Please meet at the elevators right after the session for a prompt tour start. Please sign up ahead of time here.

Campus tours

If you would like to explore campus, please find a self-guide tour pamphlet here or speak to one of the volunteers about other options.



Editor-in-Chief: Dr. Thomas Allen

Sports Engineering

Sports Engineering publishes papers on the application of engineering to sport and is the journal of the International Sports Engineering Association (ISEA). The journal is primarily interested in original contributions which concern the effect of equipment on athlete performance and safety. Using both experimental and theoretical approaches, areas of interest include: mechanics; dynamics; aerodynamics; fluid dynamics; instrumentation; sports surfaces; materials; biomechanics (related to the interaction with equipment) and safety. The journal serves as a forum where research, industry and the sports sector exchange expertise, knowledge and innovative ideas.

Visit the journal home page to:

- **See the latest journal metrics**
- **Sign up for free Table of Contents alerts**
- **Get to know the complete Editorial Board**
- **Find detailed Aims & Scope and instructions for authors**

springer.com/journal/12283

Keynote & Panel Speakers

Technology the Games Enabler

JOHN PAUL GIANCARLO

ASSOCIATE DIRECTOR OF GAMES TECHNOLOGY AND ENERGY, INTERNATIONAL OLYMPIC COMMITTEE

John is the Associate Director, Games Technology and Energy. Since joining the IOC in 2007, John has worked on with all the Olympic Games Organising Committees since Beijing 2008.

John started his Olympic career in 1998 as a Regional Technology Manager with the Sydney 2000 Olympic Organising Committee followed by four years working as a Games Technology advisor to the Athens 2004 Olympic Organising Committee. John then joined the Doha 2006 Asian Games Organising Committee as the Programme Manager for Venue Technology, where he managed the delivery of all venue technology infrastructure and operations.

As the Associate Director of Games Technology and Energy, John and his team support Host Cities, Organising Committees and key stakeholders in the planning, delivery and operations of Olympic and Youth Olympic Games technology and energy solutions, with a focus on adopting innovative technical and operational solutions, while managing risk and costs and securing legacy opportunities.

John is a citizen of the United States and Australia. Born in 1966, he has degrees in Environmental Design (Architecture) and Construction Science from Texas A&M University (USA).

JUNE 06 • 08:30 EDT
KEYNOTE

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

Simulate human body mechanics considering environment and even intention

PROF. MOTOMU NAKASHIMA

**PROFESSOR, SCHOOL OF ENGINEERING,
TOKYO INSTITUTE OF TECHNOLOGY**

Motomu Nakashima is Professor of Systems and Control Engineering at Tokyo Institute of Technology (Tokyo Tech), Japan. He graduated in Mechanical Engineering at Tokyo Tech in 1990, and received the Ph.D. in 1995. From 1995 he was Research Associate followed by Associate Professor at Tokyo Tech. From 2014 he is Professor at Tokyo Tech. His research interests are sports engineering, biomechanics, bio-robotics and welfare engineering. He is mainly working on development of simulation models in sports and its application to various fields. He was President of the Society of Aero Aqua Bio-mechanisms. He was Chair of National Research and Development Project for Paralympic Top Athletes. He is Editor of Journal of Biomechanical Science and Engineering, as well as Editorial Board Member of Sports Engineering, and Journal of Sports Engineering and Technology. He is Fellow of International Sports Engineering Association and Japan Society of Mechanical Engineers.

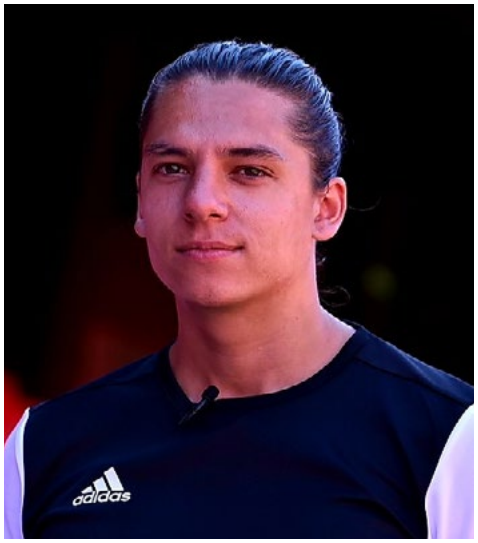
JUNE 07 • 09:30 EDT
KEYNOTE

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

The Role of Research on Football's Global Stage



JOHSAN BILLINGHAM

RESEARCH MANAGER,
FIFA

Johsan joined FIFA in 2015 and has been heavily involved in the development of the newly formed Football Technology & Innovation sub-division where he uses research to provide empirical evidence to some of the biggest technological questions in football. His work ranges from the development of new validation techniques for products, surfaces, and technologies, such as the latest Semi-Automated Offside tools for VAR, to the exploration of disruptive innovations that could make football safer, fairer, and more exciting.

JUNE 07 • 13:00 EDT
KEYNOTE

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

Human Experience of Performance

DR. TOM WALLER

SENIOR VICE PRESIDENT OF INNOVATION, ADIDAS

Dr. Tom Waller is the Senior Vice President of Innovation at adidas where the future of sport is explored and incubated with teams and facilities across the globe. He leads a rare and diverse group of multi-disciplinary scientists, technologists and creatives and is the originator of the innovation methodology known as the 'human experience of performance'. This has infiltrated all aspects of the sports, well-being, health and fitness brands he has served through a unique philosophy of blending sensory experience and human achievement. The creation of iconic products, services and experiences have driven performance on the biggest sporting stages, generated billions of dollars, won gold medals, set world records and impacted the culture of sports and leisure at scale. Formerly Chief Science Officer at lululemon, Head of Aqualab for Speedo and a pivotal member of Loughborough University's Sports Technology Institute, Tom is relentless in his pursuit of net new performance breakthrough for the world. His personal endeavours as a TEDx speaker, mountain adventurer and endurance athlete combine to fuel his energetic disruption of industry and society.

JUNE 08 • 09:30 EDT
KEYNOTE

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

Forging a Career in Sports Engineering:

How to Find Your Personal Path

DR. JONATHAN SHEPHERD

HEAD OF PERFORMANCE RESEARCH AT PING & ISEA PRESIDENT, Panel Moderator

Dr. Jonathan Shepherd is the Head of Performance Research at PING Golf and is also the current president of the International Sports Engineering Association. Jonathan's Ph.D. was awarded in the field of Sports Engineering from Griffith University collaboration with the Queensland Academy of Sport. Jonathan has regularly contributed to the scientific literature with 25 published journal articles as well as book chapters, conference organization which included the 2018 ISEA conference, contributing to a variety of sports engineering outreach and public engagement events, and supervising sports engineering students.

JUNE 08 • 13:00 EDT
PANEL

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ISEA

Forging a Career in Sports Engineering: How to Find Your Personal Path

DR. NADINE LIPPA

MATERIALS ENGINEER, WILSON SPORTING GOODS

Dr. Nadine Lippa is a materials engineer at Wilson Sporting Goods, working primarily in basketball, football, volleyball, soccer, and racket sports. She also serves on the ISEA executive committee (EC) and on the editorial board for Sports Engineering Journal (SPEN). Nadine has been involved with the ISEA EC since becoming the inaugural student representative in 2012.

Nadine earned her doctorate in Sports Engineering studying running shoe materials (polymer science) and overuse injuries (kinesiology) at University of Southern Mississippi. She then worked for a US military contractor treating the solider as the ultimate athlete, implementing forthcoming technologies for airborne and special ops protective eyewear. Nadine's focus at Wilson is performance and supply chain innovation by making sports balls in materials, methods, and locations they've never been made before. She also strives to make these innovations sustainable.

Nadine is married to a fellow PhD Sports Engineer and is thereby the mother of three very athletic and curious little children. She participates in soccer, yoga, and triathlon training to keep in shape for motherhood.

PATRICK MAYERHOFER

Ph.D. STUDENT, SIMON FRASER UNIVERSITY

Patrick is a PhD student in the Biomedical Physiology and Kinesiology Department at Simon Fraser University in Vancouver. His research focuses on leveraging wearable sensors in combination with neural networks and feedback systems to help athletes prevent injuries and increase performance. He did his undergraduate studies in Sports Equipment Technology at the University of Applied Science in Vienna and wrote his honours thesis in the Human Performance Lab in Calgary, before moving to Vancouver. Besides his research in Vancouver, he has co-developed an open-source remote wearables lab course that is being taught twice a year since 2020. Last year, he co-founded a company that aims to create a healthier balance between the real and digital world for children, and started attending business school. Patrick is also on the ISEA EC.

JUNE 08 • 13:00 EDT
PANEL

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

Forging a Career in Sports Engineering: How to Find Your Personal Path

DR. TOM ALLEN

SENIOR LECTURER, MANCHESTER METROPOLITAN UNIVERSITY

Dr. Tom Allen is a Senior Lecturer in Mechanical Engineering at Manchester Metropolitan University, where he specialises in Sports Engineering. As a Sports Engineer he is interested in the effect of engineering and technology on sport, especially in terms of performance, participation and injury risk. Tom enjoys collaborating with academic researchers, as well as working with sports brands and other organisations. He is an active member of the International Sports Engineering Association, and acts as the Editor-in-Chief of their journal Sports Engineering. Tom is also a Board Member of the International Society for Snowsport Safety and a Fellow of the Institution of Mechanical Engineers.

DR. KIM BLAIR

VICE PRESIDENT, RE:BUILD MANUFACTURING

A NASA trained engineer and Ironman triathlete, Dr. Blair has extensive experience in the development of innovative solutions to challenging technical problems in academic, start-up, small-medium enterprise, and large corporate cultures. He has proven skills in business development, strategic planning, program management, product development, team building, and engineering design and analysis. In academia, he has over a decade of experience developing and delivering innovative, hands-on educational programs in engineering, and innovation and product development processes. An ISEA member for nearly 20 years, he has served on the Executive Committee as Secretary, President, Past President, and Senior Advisor. Currently, Dr. Blair is Vice President at Re:Build Manufacturing, a family of industrial businesses combining cutting-edge enabling technologies, operational superiority, and strategic M&A to build the USA's next generation industrial company.

JUNE 08 • 13:00 EDT
PANEL

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The Importance of Engineering in Sport

MICHAEL ROGERS

HEAD OF ROAD & INNOVATION,
UNION CYCLISTE INTERNATIONALE (UCI)

Michael is inspired by high performing teams. As a professional cyclist, Michael enjoyed a successful career that spanned 16 years, during which he competed at 4x Olympic Games, became the first male cyclist in history to win 3x consecutive world time trial championships and won stages at the Tour de France and Tour of Italy. Since leaving the pro cycling world as a rider, Michael has continued to pursue his fascination with the factors that lead to becoming the best - whether that be as a world-class athlete, an entrepreneur, a leader in an established organization. Michael is Head of Road & Innovation at the Union Cyclist Internationale (World Cycling Federation).

Michael lives in the Italian speaking area of Switzerland. When he is not working he enjoys spending time with wife and three daughters, walking his dogs, reading and exploring topics ranging from current affairs, real estate and finance. And of course, he still adores riding his bike.

JUNE 09 • 09:00 EDT
KEYNOTE

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

The Future of Sports?

Merging the Digital and Physical

STACEY BURR

WEARABLES GM AND ENTREPRENEUR,
Panel Moderator

Stacey has spent the last 20 years focused on helping people reach their health & fitness goals through body-worn sensors, data, and digital technology. She has a strong track record of commercial growth via invention, acquisition, partnerships, and organic product development.

Stacey has been a Google VP for product, UX, and engineering teams for Google Fit, Wear Operating System and Fitbit. She was the Vice President, General Manager of adidas Digital Sport, where she led the creation, development and operations of adidas wearable sports electronics and fitness app experiences. Following a career at DuPont, Stacey founded and served as CEO of Textronics Inc, a pioneer in electro-textiles that was sold to adidas in 2008. She is the co-inventor of 76 patented materials and process technology innovations in wearable electronics, and co-chairs the annual WEAR conference.

Stacey holds a BS in industrial engineering and an MS Industrial Administration with a marketing and operations emphasis from Purdue University.

JUNE 09 • 13:00 EDT
PANEL

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Ray Ewry Sports Engineering Center

ISEA

The Future of sports? Merging the Digital and Physical

AMANDA CARLSON-PHILLIPS

SENIOR VICE PRESIDENT AND HEAD OF PERFORMANCE INNOVATION, EXOS

Amanda Carlson-Phillips is senior vice president and head of performance innovation at Exos. As Exos moves into the future, she's responsible for leading the performance innovation team in reinvigorating the way Exos works, bringing value to our products, services, and practitioners using Exos' methodology in the field while maintaining Exos' position as a thought leader in the field of human performance. A nearly 20-year Exos vet, Amanda spent 15 years establishing Exos' nutrition and research capabilities before transitioning to leading strategic partnerships, insights, and industry relations. She's a registered dietitian and has a bachelor's degree in nutritional science from University of Arizona and a master's degree in movement science and sports / clinical nutrition from Florida State University.

DR. KRISTOF DE MEY

SPORTS TECH, INNOVATION, & BUSINESS DEVELOPER, GHENT UNIVERSITY

Kristof De Mey is working as a Sports Technology, Innovation and Business developer at Ghent University (Belgium) where he is managing a consortium of experts called Victoris. He's involved in various university-industry collaborations, licensing and spinout projects related to the work of different research teams. He's also lecturing a Sports Technology and Innovation course at the same university.

Together with imec.istart, he started an initiative called SportUp, which functions as the Flemish/Belgian program supporting local and international startups within sport. With a special focus on societal impact, he co-founded the non-profit organization Sportamundi, which helps in generating, developing and implementing various evidence-based tools in schools and physical education settings, federations and cities and municipalities.

Lastly, with the objective to better connect the best sports, tech and business scientists with each other and with research-driven industry representatives, he launched the Sports Tech Research Network, an initiative which aims to facilitate the creation and go-to-market of more effective sports tech products and services with the help of science.

JUNE 09 • 13:00 EDT
PANEL

PURDUE UNIVERSITY | College of Engineering

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The Future of sports?
Merging the Digital and Physical

DR. SCOTT MCLEAN

PRINCIPAL - BIOMECHANICS, EXPONENT

Dr. McLean's areas of expertise include injury biomechanics, gait and locomotion and human performance assessment and modification, publishing extensively in each of these fields. He has more than two decades of experience in analyzing and countering injury mechanisms via a combination of human experimentation, cadaveric and computational modeling approaches. Dr. McLean also has considerable expertise in applying state-of-the-art wearable technologies to the optimization of human movement and performance within a variety of clinical, sporting and military settings.

Prior to joining Exponent, Dr. McLean was the Director of Human Innovation Research at Fitbit, where he derived and lead a number of key research initiatives focusing on characterization and improvement of wearable product accuracies and performance on a global scale. He was also a Professor at the University of Michigan, where he drove a number of high-profile research studies geared towards human performance optimization and injury assessment and prevention within naturalistic military and sports environments. He initially was a Project Staff Scientist and the Director of Sports Health and Orthopedic Rehabilitation at the Cleveland Clinic, where he was the team biomechanical consultant for Cleveland's professional sporting teams.

JUNE 09 • 13:00 EDT
PANEL

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Wilson

INDY ELEVEN

SPECIALIZED

ISEA
INTERNATIONAL SPORTS ENGINEERING ASSOCIATION

PURDUE ATHLETICS

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RESEC
Ray Ewry Sports Engineering Center

Hosts & Committees

ORGANIZING COMMITTEE

PROF. JAN-ANDERS MANSSON

EXECUTIVE DIRECTOR, RAY EWRY SPORTS ENGINEERING CENTER

Professor Jan-Anders E. Mansson, obtained his PhD from Chalmers University, Sweden. After some years in industry, he was appointed Professor at the University of Washington. In 1990, Mansson joined EPFL, Lausanne, as Professor and head of the Composite Laboratory where he also served as Vice-President for the University.

In 2016 he came to Purdue University as Distinguished Professor of Engineering, where he founded the Manufacturing Design Laboratory (MDLab) equipped as a fully integrated Industry 4.0 Composite Manufacturing testbed. He also serves as the Executive Director of the newly created Ray Ewry Sports Engineering Center at Purdue in close links with the International Olympic Committee (IOC). He is currently also the Chairman of the Swimwear Approval Committee of the International Federation of Swimming (FINA) and on the Board of IOC's Athlete Learning Gateway.

Prior to joining Purdue in 2016, Mansson served for over 10 years as President of the International Sport Academy (AISTS), an International Olympic Committee (IOC) co-founded organization linking several Academic Institutions. In the sport related field, Mansson also led, among others, the scientific activities for the winning Swiss America's Cup yacht Alinghi, the Solar Impulse and l'Hydroptère. Mansson is a World Fellow of the International Committee on Composite Materials (ICCM) and founder of the company, EELCEE Ltd. He is member of the Swedish and the Swiss Academy of Engineering Sciences.

ANNA GIESLER

DIRECTOR, RAY EWRY SPORTS ENGINEERING CENTER

Anna Giesler is the Director of the Ray Ewry Sports Engineering Center and a graduate student in Materials Engineering at Purdue University. Her primary focus is building up the activities of RESEC through research, launching the professional master's program, and strengthening collaborations with industrial and academic partners. She currently serves on the ISEA Executive Committee and on the Purdue Dean of Engineering's Executive Advisory Committee.

She graduated from Purdue University Honors College in May 2020 with a BS in materials engineering. She was an NCAA Division 1 and Big Ten swimmer at Purdue, competing for four years on the varsity swim team, and is a two-time Big Ten Distinguished Scholar. Her previous research focused on homologation of technical swimsuits and the degree of influence of different variables on permeability.

Originally from Holland, Michigan, Anna has always enjoyed being on the water and going on adventures. She swam competitively for 16 years, grew up sailing every summer, and has a passion for travel.

ORGANIZING COMMITTEE

DR. KIM BLAIR

VICE PRESIDENT, RE:BUILD MANUFACTURING

A NASA trained engineer and Ironman triathlete, Dr. Blair has extensive experience in the development of innovative solutions to challenging technical problems in academic, start-up, small-medium enterprise, and large corporate cultures. He has proven skills in business development, strategic planning, program management, product development, team building, and engineering design and analysis. In academia, he has over a decade of experience developing and delivering innovative, hands-on educational programs in engineering, and innovation and product development processes. An ISEA member for nearly 20 years, he has served on the Executive Committee as Secretary, President, Past President, and Senior Advisor. Currently, Dr. Blair is Vice President at Re:Build Manufacturing, a family of industrial businesses combining cutting-edge enabling technologies, operational superiority, and strategic M&A to build the USA's next generation industrial company.

SCIENTIFIC COMMITTEE

Andrew Alderson
Sheffield Hallam University

Bert Blocken
Eindhoven University of Technology

Matt Carre
The University of Sheffield

Richard Greenwald
Simbex

Steve Haake
Sheffield Hallam University

John Hart
Sheffield Hallam University

Mont Hubbard
University of California, Davis

David James
Labosport UK

Motomu Nakashima
Tokyo Institute of Technology

Nicola Petrone
University of Padua

Veit Senner
Technical University of Munich

Kazuya Seo
Yamagata University

Lloyd Smith
Washington State University

Tom Waller
Lululemon Athletica

Paul Wood
Ping

Matthew Worsey
Griffith University

PROCEEDINGS EDITORS

REVIEW COMMITTEE

Awards & Explore Purdue

AWARDS

RESEC Awards

The Ray Ewry Sports Engineering Center (RESEC) is pleased to present three awards in alignment with their core research focuses: the excitement, health and safety, and integrity of sport. Each award will go to the paper (oral or poster) that demonstrates the highest quality of research (in methodology, outcome, and approach) that advances sport in that area.

RESEC Excitement Award

RESEC Health & Safety Award

RESEC Integrity Award

adidas Inclusivity in Sports Research Award

adidas is proud to present the Inclusivity in Sports Research Award. This prize will be awarded to the orally presented paper that best uses inclusive research methods to fill data gaps around underrepresented high performers, and improve our understanding of all athletes.

Best Student Presentation Award

The Ray Ewry Sports Engineering Center (RESEC) is excited to present the award for Best Student Presentation. This award recognizes the best presentation (oral or poster) by a student which demonstrates the highest quality of research (in methodology, outcome and approach) exhibiting a significant output to the sports engineering community.

PURDUE UNIVERSITY | College of Engineering

Ray Ewry Sports Engineering Center

ISEA

ISEA

INTERNATIONAL SPORTS ENGINEERING ASSOCIATION

STUDENT PROJECT COMPETITION

What is it?

The ISEA Student Project Competition is an annual, international competition for sports engineering students. The competition is open to undergraduate, masters, and PhD students, at any institution of higher education in the world, who have undertaken a project on a sports engineering or sports technology topic.
Projects are defined as work wherein the students are the primary contributor. Both individual and group submissions are eligible.

Win Great Prizes!

2 — £200 + 1y ISEA Full-Membership*

1 — £400 + 1y ISEA Full-Membership*

3 — £100 + 1y ISEA Full-Membership*

*The prize funds for group submissions will be shared equally among members and each member will receive student ISEA membership for one year.

Sounds cool?

You are an undergraduate, masters, or PhD student? ✓

You have recently done a sports engineering project? ✓

Submit your infographic!

What's to be judged?

- Originality
- Academic rigour
- Presentation
- Knowledge transfer potential

Submission Process

- Prepare your infographic
  Include the ISEA logo (download link below)
- Include name(s) & contact
  Submit 2 versions (with names & anonymized)
- Send PDF or PNG to
  isea@shu.ac.uk

Present your project on our social media channels!

Dissemination

ISEA

I: http://www.sportsengineering.org/
E: isea@shu.ac.uk

Explore West Lafayette

Food and Drink • Things to Do • Run/Bike Trails • Links for More

8Eleven Modern Bistro

"A modern bistro located in the Historic Union Club Hotel at Purdue University. Serves a menu of approachable American classic dishes with a few French signatures."

201 Grant St, West Lafayette, IN 47906

Triple XXX Family Restaurant

"Better burgers. Unbelievable root beer. Breakfasts to die for. A praiseworthy piece of America's past and present, can be found right here at The Triple XXX."

2 N Salisbury St, West Lafayette, IN 47906

East End Grill

"East End Grill merges classic steakhouse dishes with innovative bistro style. The menu combines simple yet hearty fare ranging from chopped salads, to burgers & sandwiches and the best steaks and seafood available."

1016 Main St, Lafayette, IN 47901

Visit Insomnia Cookies

Enjoy a wide variety of warm delicious cookies. Utilize quick delivery or stop by and pick up your sweet treat to go.

602 W Stadium Ave, West Lafayette, IN 47906

Stop at Greyhouse Coffee

"In the heart of Purdue, we offer the highest quality coffee in a warm atmosphere with a menu of crepes, gelato, doughnuts and desserts."

100 Northwestern Ave, West Lafayette, IN 47906

Explore Beautiful Public Art

Explore hundreds of displays of public art. Follow the trail at: https://www.lafayette.in.gov/DocumentCenter/View/8077/Public-Art

Happy Hollow Park

"Happy Hollow Park is approximately 81 acres in size with 1 mile of paved Trolley Line Trail (hiking) and approximately 1 mile of Footpaths."

1301 Happy Hollow Rd, West Lafayette, IN 47906

Celery Bog Nature Area

" A tranquil spot for wildlife and people alike. You'll find some unusual plants and the opportunity to view nearly 120 different species of birds."

1620 Lindberg Rd, West Lafayette, IN 47906

Virtuous Cycles Bike Rentals

"Rent and buy our bikes, custom fit for your specific needs. Witness the benefits of a bike assembled by knowledgeable mechanics."

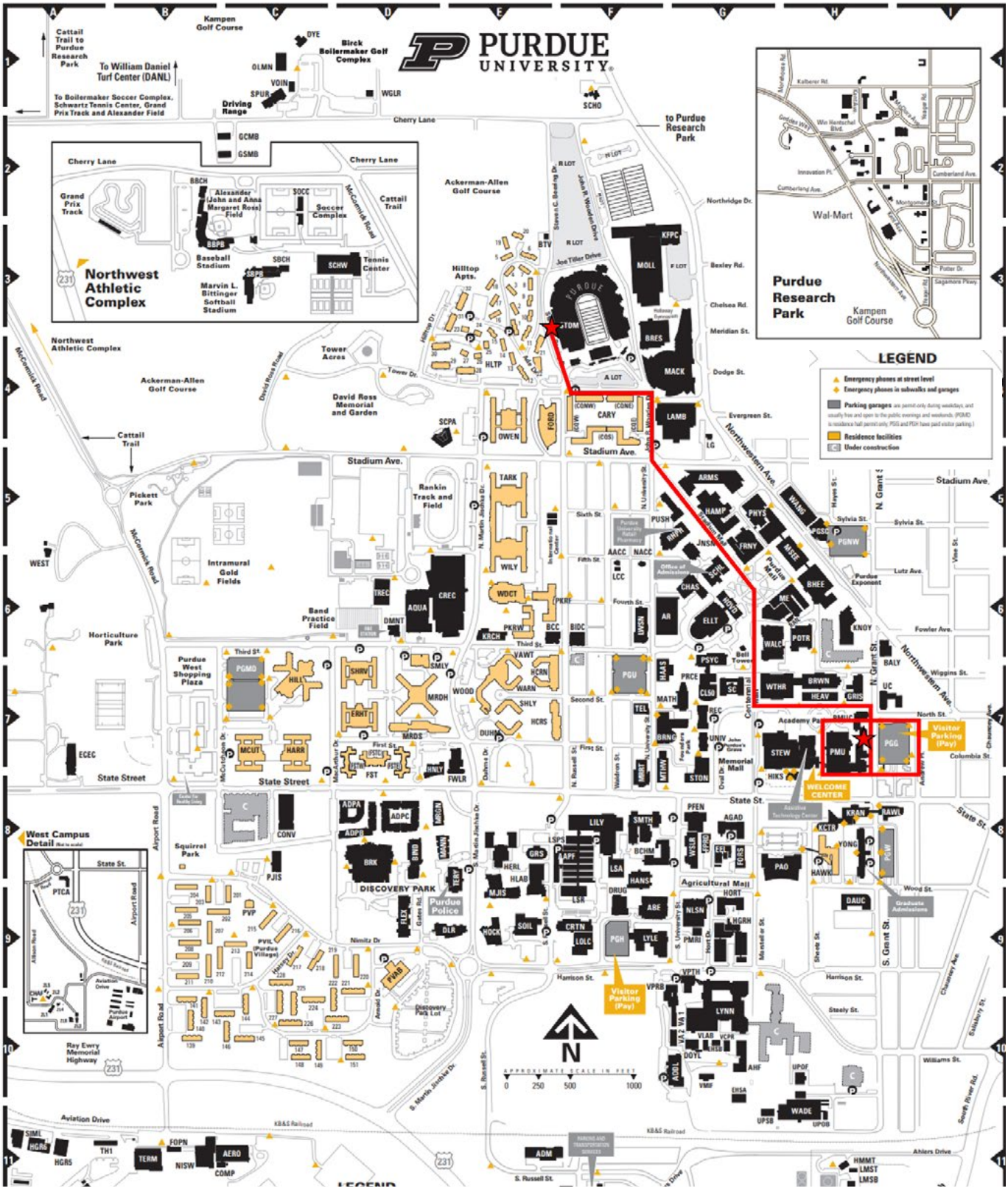
215 N 10th St, Lafayette, IN 47901

CityBus Routes: https://gocitybus.com/maps-and-schedules

Parks: https://www.westlafayette.in.gov/egov/documents/1533845770_34312.pdf

More: https://www.homeofpurdue.com/downtown/

PURDUE CAMPUS MAP



ISEA 2022

Engineering of Sport 14

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