Workshops & Tutorials

Workshops and Tutorials are available to all registered attendees. The fee associated with each session is $25 unless noted otherwise.

Workshops

Workshop 1 — Sustainability and Optimization: Theory and Practice

August 18, 2019
9:00AM–12PM
El Capitan A, 4th Floor

Organizer

Nand K. Jha
Manhattan College, Riverdale
Nand.Jha@Manhattan.Edu

Abstract:

Sustainability and Optimization: Theory and Practice presents a unique combination of optimization to sustainability problems. It is the product of about 40 years of teaching Mechanical Engineering courses in design and manufacturing. The mathematical programming methods are quite developed theoretically, but its applications to sustainability problems are limited almost non-existent. The relation and interaction between optimization and sustainability is clear as we want to optimize the use of natural resources and minimize the environmental degradation. There are bits and pieces of such interaction available here and there in research journals, but it is not discussed rigorously threadbare by researchers and academicians. The symposium will discuss complete theory and practical or real world problems. To avoid the environmental catastrophes, the carbon neutral footprint of engineering decisions in design and manufacturing, we need to recognize the importance of optimization and sustainability relation. To save resources and materials for future generations, the importance of minimization of wastage, maximization of recycling and reuse must be attempted.

Expected Audience:

I believe this workshop should interest academicians, theoretical scientist, industry people, green designers, and sustainable manufacture people both from academy and industry. I have participated in some seminars and conferences where people from industry have lot of interest in such topics. Academicians will have occasion to present their research on this unique combination of optimization and sustainability. I have been teaching such courses and I find undergraduate and graduate students are becoming highly environmentally conscious and they love such topics.

Course Outline:

1. Mathematical Foundation of Sustainability: Mathematical Tools for Sustainability

2. Maximization of Profit Versus Sustainability

3. Sustainability Principles and their effect on design and manufacturing, and other engineering fields

4. Maximization of Recyclability and Reuse for Sustainability

5. Carbon Neutral Footprint for Sustainable Development: engineering product development, life cycle analysis, and optimization

6. Revision of Theory of Optimization for Sustainable Development

7. Resources Constrained Optimization Problems and Sustainability

8. Structured Geometric Programming Formulation with Sustainability Considerations

9. Examples of PGP in sustainable engineering problems; reuse, recycle, and reconfiguration

10. Sensitivity Analysis Under Sustainable Considerations

11. Real World Stochastic Problems Under Sustainability Considerations

12. Profiting From Sustainability

13. Manufacturing Sustainability: Theory and Practices

Workshop 2 — Advanced Design, Simulation, and Finite Element Analysis of Gear Drives

August 18, 2019
1:00PM–5:00PM
El Capitan B, 4th Floor

Organizer

Alfonso Fuentes-Aznar
Rochester Institute of Technology
afeme@rit.edu

Abstract:

Although gears are one of the oldest mechanical components, the technology of gear design and simulation still faces challenges and constant pressure to achieve improved designs with lower levels of noise and vibration suitable for longer operation time and/or higher power density. This workshop offers the possibility to interact and learn advanced gear design and simulation principles to achieve the above-mentioned goals by using state-of-the-art computational tools for virtual generation of gears and application of tooth contact analysis (TCA) and finite element analysis (FEA). The workshop includes the following topics: application of micro-geometry modifications to avoid edge contact and absorb errors of alignment; free-form design of gear tooth surfaces; evaluation of the loaded function of transmission errors and mesh stiffness as the main cause of noise and vibration during operation; compensation of errors of alignment caused by shaft deflections; and advanced design of spiral bevel gear drives.

Presenter Biography:

Alfonso Fuentes-Aznar has more than twenty years of experience studying the processes of gear generation and micro-geometry modifications. He also focuses on developing the computational tools that gear designers require to improve existing designs or develop new ones with superior conditions of meshing and contact.

He is currently involved in the development of improved gear transmissions for the helicopter, marine, and automotive industries, and enhanced design technologies for all types of gears like the software IGD (Integrated Gear Design). The purpose of this software is to serve as the ultimate tool for advanced gear design, analysis, and simulation of gear drives.

Dr. Fuentes is the director of the Gear Research Consortium at the Rochester Institute of Technology in Rochester, NY. Several awards recognize his research including a NASA Tech Brief Award in 2004 for the development of a technology entitled, "New geometry of face worms gear drives with conical and cylindrical worms" and the Thomas Bernard Hall Prize in 2001, granted by the Institution of Mechanical Engineers of London to authors of outstanding papers dealing with invention, design, or research in Mechanical Engineering. Dr. Fuentes has authored two research books and more than a hundred publications including journal articles, conference papers, and technical reports. His coauthored book, *Gear Geometry and Applied Theory* has been cited more than 2,600 times thus far. Since 2015, he is the gear and cam subject editor for the journal, *Mechanism and Machine Theory.*

Expected Background of Participants:

Participants should be familiar with the nomenclature and terminology related to gear technology and design, analysis, and simulation of gear drives.

Expected Audience

This workshop is aimed to gear designers, researchers, graduate students, and general participants of the International Power Transmission and Gearing Conference (PTG) interested in the capabilities of state-of-the-art computational tools for advanced design and simulation of gear drives.

Need for the Workshop or Tutorial

The process of gear design is an extremely wide and critical area, based on simplified models and analytical equations with many empirical parameters. This workshop offers a very different approach focused on the virtual generation of the geometry of the gears, the application of micro-geometry modifications, and the evaluation of the mechanical performance by application of tooth contact analysis (TCA) and finite element analysis (FEA). **This workshop will teach participants new approaches for gear design and simulation and compare them with current practices of design and simulation. Participants will understand how up to date their current practices are and whether or not the presented technologies can improve them.**

Impact:

This workshop will encourage discussion among the participants about current practices of gear design, thus generating recommendations for the development of computational tools for the gear industry. New collaborations between participants may arise to benefit the gear research community and industry.

Course Outline:

1. Virtual generation of gear drives and exporting capabilities to main CAD computer programs

2. Application of tooth contact analysis (TCA) and finite element analysis (FEA) to evaluate the mechanical performance of gear drives

3. Evaluation of loaded functions of transmission errors and mesh stiffness as rootcause of noise and vibration during operation

4. Application of free-form design of gear tooth surfaces to evaluate different micro-geometry modifications

5. Compensation of errors of alignments caused by shaft deflections by advanced simulation of gears with their supporting shafts and bearings

6. Advanced design and simulation of different types of gear drives, including spiral bevel gears

7. Reverse engineering of gear tooth geometries by application of data obtained from non-contact metrology machines

Workshop 3 — Workshop on Trends in Connected and Autonomous Vehicles

August 18, 2019
1:00PM–5:00PM
Avila A, 4th Floor

Organizers

Beshah Ayalew
Clemson University
beshah@clemson.edu

Costin Untaroiu
Virginia Tech
costin@vt.edu

Abstract:

The goal of this workshop is to provide exposure for participants to the emerging trends on connected and autonomous vehicles (CAV). These technologies are expected to have a huge impact on traffic safety, energy efficiency, and provision of mobility to all. These technologies are likely to lead to a seismic change in how on-road transportation is viewed, how vehicles are designed and manufactured, and how they are utilized. The following speakers have been invited and accepted the invitations to present and stimulate the discussions at the workshop.

This workshop is sponsored by the Vehicle Design Technical Committee (VD TC) with a grant from the ASME DMM Select Leadership Team.

1. Effectiveness, Functional Performance, and Driver Acceptance of Commercially Available Advanced Driver Assistance Systems

Presenter: Ian Reagan
Insurance Institute for Highway Safety

Abstract:

The Insurance Institute for Highway Safety assesses real world effectiveness of advanced driver assistance and collision avoidance systems by comparing the insurance claim and police reported crash experience of vehicles equipped with a given technology against the same make and model vehicles without the same technology. The pattern of results from this work demonstrates that these systems are associated with lower rates of claims and crashes; although the magnitude varies across automaker and safety system.

The Institute is also actively involved with understanding driver acceptance and use of advanced driver assistance technology, including commercially available driving automation. Multiple IIHS studies have identified meaningful differences in driver perception of different technologies and differences in perception of the same technologies implemented by different automakers. This work has identified characteristics of a technology that are associated with higher levels of driver acceptance and guided functional performance testing of different production vehicles equipped with partial driving automation.

Presenter Biography:

Ian Reagan is a senior research scientist at the Insurance Institute for Highway Safety. Since joining the Institute in 2012, Dr. Reagan has conducted research on such topics as drive acceptance and use of crash avoidance and advanced driver assistance technologies as well as driver distraction. Previously, he worked for the National Highway Traffic Safety Administration as a research psychologist. Dr. Reagan received a bachelor's degree and a doctorate in psychology from Old Dominion University.

2. Automated Driving Systems: A Silver Bullet Automotive Safety Solution or a Wolf in Sheep's Clothing?–A Continuum of Consequences Is Considered.

Presenter: Warren N. Hardy
Virginia Tech

Abstract:

Automated driving systems (ADS) have been touted as being a panacea for societal ills related to ground-based driving casualties. Profound reductions in injury and death for vehicle occupants, pedestrians, and cyclists are expected as the human error component is removed. Both government and industry are working to deploy ADS of various levels quickly. Although this paradigm shift in transportation seems obvious and prudent on its surface, is it really so unambiguous?

How and how fast are these systems to be deployed? By when will there no longer be a mixed fleet? When will satisfactory infrastructure become widespread? In the near term, many ADS features can be implemented on conventional vehicle platforms, leveraging all that is known in the field of impact biomechanics and maintaining current safety performance during crash events. However, the novel occupant compartment configurations anticipated to arrive in the not-too-distant future will require as-yet-unimagined active and passive safety system components and will create a need for human impact response and tolerance data not available now. Further, new crash performance assessment tools and techniques will be necessary. What will these be? How are ADS vehicles to be certified? How can Federal Motor Vehicle Safety Standards (FMVSS) be applied?

ADS will not eliminate crashes in the foreseeable future. As crashes are reduced, those that occur are likely to arise from shortness of time to react, which will be associated with faster-moving vehicles, resulting in higher-speed crashes. Novel seating arrangements such as rear and side facing positions will pose significant safety challenges, as will postures involving significant recline. Some envision traveling without seatbelts. The biomechanics community has no data for such scenarios. Forward-facing rear seat occupancy is on the rise, which is cause for concern as there are no FMVSS imposed on the rear seat. Real-world and recent laboratory data are presented to provide context for this discussion. Judicious introduction of this promising technology is critical to its acceptance and success.

Presenter Biography:

Warren Hardy has studied human response to impact, tested properties of biomaterials, designed cash dummy components, and implemented FE models related to injury mitigation, and he has examined restraint design for over 35 years. Over that time, he has conducted research at the Wayne State University (WSU) Bioengineering Center and the University of Michigan Transportation Research Institute (UMTRI). He has served as a faculty member in the WSU Biomedical Engineering Department, and currently serves in the Mechanical Engineering Department at the Virginia Polytechnic Institute and State University (VT). He is the Director of the Center for Injury Biomechanics at VT. He is most known for his expertise in traumatic brain injury (TBI), traumatic rupture of the aorta (TRA), abdominal injury, and soldier protection. He received his bachelor's degree in Engineering Science (Bioengineering) from the University of Michigan and a master's in Mechanical Engineering and Ph.D. in Biomedical Engineering from WSU. Dr. Hardy has won the John Paul Stapp Award five times and sits on the Stapp Advisory Committee as immediate past General Chair of the Stapp Car Crash Conference. He is the Chair of the SAE Automated Driving Systems Crashworthiness Task Group and the Editor in Chief of the *SAE International Journal of Transportation Safety*. Dr. Hardy is a Fellow of SAE and a member of ASME, IEEE, and AAAM.

3. Anticipative Guidance of Connected and Autonomous Cars for Energy Efficiency

Presenter: Ardalan Vahidi
Clemson University

Abstract:

Connected and automated vehicles (CAV) are marketed for their increased safety, driving comfort, and time saving

potential. With much easier access to information, increased processing power, and precision control, they also offer unprecedented opportunities for energy efficient driving. This talk highlights the energy saving potential of connected and automated vehicles based on first principles of motion, optimal control theory, and practical examples from our previous and ongoing research. Connectivity to other vehicles and infrastructure allows better anticipation of upcoming events, such as hills, curves, slow traffic, state of traffic signals, and movement of neighboring vehicles. Automation allows vehicles to adjust their motion more precisely in anticipation of upcoming events, and save energy. Opportunities for cooperative driving could further increase energy efficiency of a group of vehicles by allowing them to move in a coordinated manner. Energy efficient motion of connected and automated vehicles could have a harmonizing effect on mixed traffic, leading to additional energy savings for neighboring vehicles. We present analytical and experimental results from a US DOE funded project in which we are exploring the impact of anticipative vehicle guidance on energy efficiency of CAVs and surrounding traffic. The benefits are shown in simulated scenarios and also in a novel vehicle-in-the-loop experiment on a test track.

Presenter Biography:

Ardalan Vahidi is a Professor of Mechanical Engineering at Clemson University, South Carolina. He received his Ph.D. in mechanical engineering from the University of Michigan, Ann Arbor, in 2005, M.Sc. in transportation safety from George Washington University, Washington, DC, in 2002, and B.S. and M.Sc. from Sharif University, Tehran in 1996 and 1998, respectively. In 2012–2013 he was a Visiting Scholar at the University of California, Berkeley. He has also held scientific visiting positions at BMW Technology Office in California, and at IFP Energies Nouvelles, in France. His research is at the intersection of energy, vehicular systems, and automatic control. His recent publications span topics in alternative vehicle powertrains, intelligent transportation systems, and connected and autonomous vehicle technologies.

4. Personalized Control for Connected and Automated Vehicles: Safety, Efficiency, and Trust

Presenter: Junmin Wang
University of Texas at Austin

Abstract:

The recent advances on vehicular communication, computational, and automation capabilities have paved the way for substantially improving vehicle safety and efficiency. To realize the ultimate operational efficiency and roadway safety in real-world operations, future-generation vehicles need to be implanted with the capacity and intelligence that enable them to become adaptive and reliable personal partners of their human users. Given the immense variations on human users and countless operating conditions, learning-based and personalized vehicle controls that explicitly take into account individual humans' driving characteristics, skills, and riding preferences become imperative to address the grand mobility challenges facing our society. Personalized vehicle control can substantially enhance vehicle operational efficiency, driving safety, and human trust to automation by actively learning from individual drivers/users and self-tailoring the control systems. This talk introduces some recent work on personalized control for connected and automated vehicles aiming to improve safety, efficiency, and trust in real-world operations. Along with the system analytical designs, experimental and simulation results will be given to demonstrate the importance and efficacy of the personalized vehicle control.

Presenter Biography:

Junmin Wang is the Accenture Endowed Professor in Mechanical Engineering at University of Texas at Austin. In 2008, he started his academic career at Ohio State University, where he founded the Vehicle Systems and Control Laboratory, was early promoted to Associate Professor in September 2013, and then very early promoted to Full Professor in June 2016. He also gained five years of full-time industrial research experience at Southwest Research Institute (San Antonio, Texas) from 2003 to 2008. Prof. Wang has a wide range of research interests covering control, modeling, estimation, optimization, and diagnosis of dynamical systems, especially for automotive systems, smart, sustainable, and autonomous mobility, human-centric automation, and cyber-physical system applications. Dr. Wang is the author or co-author of more than 290 peer-reviewed publications including 140 journal articles and 13 U.S. patents. Prof. Wang is a recipient of numerous international and national honors and awards including 2018 IEEE Andrew P. Sage Best Transactions Paper Award, 2017 IEEE Transactions on Fuzzy Systems Outstanding Paper Award, 2012 NSF-CAREER Award, 2011 SAE International Vincent Bendix Automotive Electronics Engineering Award, and 2009 ONR-YIP Award. He is an IEEE Vehicular Technology Society Distinguished Lecturer, SAE Fellow, and ASME Fellow.

Dr. Wang received the B.E. in Automotive Engineering and his first M.S. in Power Machinery and Engineering from the Tsinghua University, Beijing, China in 1997 and 2000, respectively; his second and third M.S. degrees in Electrical Engineering and Mechanical Engineering from the University of Minnesota, Twin Cities in 2003; and the Ph.D. degree in Mechanical Engineering from the University of Texas at Austin in 2007.

Expected Background of Participants:

There are no required or expected areas of experience or knowledge or expertise except interest to learn about the latest issues about automated and connected vehicle technology.

Expected Audience

This workshop is aimed at attracting all engineers from industry and academia interested in the emerging topic of automated and connected vehicles. ASME AVT conference attendees are specially expected to find this useful.

Impact

This workshop is intended to bring the discussion of the connected and automated vehicle design and operational issues to the IDETC/CIE conferences, which currently do not address these important technological advances of our time.

Course Outline:

The proposed focused workshop will run as moderated blocks on the Sunday before the ASME IDETC 2019 conference for the convenience of potential ASME attendees.

1:00PM–2:30PM Focus on Advanced Drivers Assistance, ADS Safety and Regulations

2:30PM–2:45PM Break

2:45PM–5:00PM Focus on CAVs and Energy Efficiency

Workshop 4 — Hydrokinetic Energy Harvesting

August 18, 2019
1:00PM–5:00PM
Avila B, 4th Floor

Organizer

Cornel Sultan
Virginia Tech
csultan@vt.edu

Abstract:

Exploiting clean energy resources is a crucial element of sustainability. Recent multidisciplinary advances in system design, signal processing, automatic control, power electronics, computational capabilities, and materials enable clean energy harvesting systems of increased efficiency. In particular, harvesting the energy of ocean waves and currents is expected to see tremendous global growth in the near future. Following these recent advances, this workshop presents an overview of the critical needs, fundamental principles, and challenges related to energy harvesting from kydrokinetic sources. Characterization of the marine environment in which such devices will operate and specific difficulties for the design of these systems are discussed. The workshop addresses existing and future systems, key design principles, as well as modeling issues. Since marine energy systems will operate in extreme environments with limited opportunities for regular maintenance, autonomy will play a critical role. Therefore, feedback control design for these system is also discussed. Relevant and illustrative examples are included.

Presenter Biographies:

Cornel Sultan received a Ph.D. in Aeronautics and Astronautics from Purdue University in 1999. He was affiliated with a start-up company, Tensegra Inc., Scientific Systems Company Inc., Harvard Medical School, and United Technologies Research Center. He joined Virginia Tech's Aerospace and Ocean Engineering Department in 2007 where he built up a research program in tensegrity and membrane structures, rotorcraft, and energy harvesting systems. He is a core Faculty of Virginia Tech's NSF I/UCRC Center for Energy Harvesting Materials Systems (CEHMS). Dr. Sultan's work on marine energy systems, supported by the National Science Foundation, addresses fundamental aspects of the dynamics and control of ocean current turbines. Control innovations inspired by helicopter control technology are of particular interest, as well as advanced control of marine energy systems in the presence of uncertainties and failures.

Songwei Sheng earned his Ph.D. from the University of Chinese Academy of Sciences in 2012, and was appointed as professor in 2017. He has been studying the theory and technology of wave energy conversion, and ocean engineering technology in wave energy utilization since 2002. He is the director of Ocean Energy Laboratory, Guangzhou Institute of Energy Conversion (GIEC). He has published more than 17 papers in reputed national and international research journals. He has taken charge of three national scientific projects, and successfully researched and developed 10kW Sharp Eagle WEC and 100kW Sharp Eagle *"Wanshan"* with independent intellectual property rights. He is undertaking two important national scientific projects, one of which is funded over 100 million RMB. He has applied for more than 20 invention patents at home and abroad. Among them, semi-submersible wave power generating device has been granted in China, USA, Australia, and UK. He received provincial and ministerial level awards due to his outstanding contributions. He has been serving as a council member of China Ocean Engineering Society and Guangdong Ocean Society.

Zhenpeng Wang received his doctor's degree in Fluid Machinery and Engineering from the University of Chinese Academy of Sciences in 2017. He is an assistant professor at Ocean Energy Laboratory, Guangzhou Institute of Energy Conversion (GIEC), Chinese Academy of Sciences (CAS), and focusing on the optimization of Power Take-off system in wave energy converters.

Expected Background of Participants:

Previous exposure to multibody systems modeling, turbomachinery, hydrodynamics, and modern control is recommended but not critical.

Expected Audience

This workshop addresses graduate and undergraduate students, engineers from industry, as well as faculty interested in hydrokinetic energy harvesting. Professionals working in related areas such as rotating turbomachinery, vibrations, system design, mechanical, electrical, ocean engineering, control, and autonomy may find topics covered in this workshop interesting as well.

Need for the Workshop or Tutorial

Recent concerns related to sustainability and the environment prompted growing interest in novel systems and materials for efficient energy harvesting from various sources. In this context energy harvesting from hydrokinetic sources is crucial, given their widespread distribution. Therefore, the proposed workshop is both timely and relevant. By bringing together established experts as well as students from diverse areas, such as dynamics, control, and mechatronics, the workshop is expected to foster interdisciplinary cooperation. The workshop will educate the audience about opportunities and challenges in marine energy harvesting while also presenting recent advances in energy harvesting from ocean current and waves. Furthermore, the workshop will show how knowledge from different fields can be leveraged to address complex problems.

Impact:

Due to the wide spectrum of energy harvesting solutions and ideas presented, the workshop will have broad impact in the mechanical engineering community, as well as in the controls and materials communities, because it will include control, design, and materials discussions. On the educational aspects, we expect to excite student interests in nonconventional energy harvesting and sustainability.

Course Outline

Part 1: Generalities of Marine Energy Harvesting
- Marine environment characterization: waves, currents, hydrokinetics
- System design challenges and opportunities
- Classification of marine energy harvesting systems

Part 2: Wave Energy Converters (WEC)
- Design principles of WEC
- Power takeoff
- Open sea tests challenges

Part 3: Ocean Currents Turbines (OCT)
- Design principles of OCT
- Power generation and blade control
- Control design for OCT autonomy

Workshop 5 — Leveraging Strengths for Effective Communication and Collaboration

August 18, 2019
1:00PM–6:30PM
San Simeon A, 4th Floor

Organizers

Christine Toh
University of Nebraska Omaha
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Elizabeth Starkey
Pennsylvania State University
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Charlotte de Vries
Pennsylvania State University
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Shraddha Joshi
James Madison University
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Abstract:

The goal of the workshop on Leveraging Strengths for Effective Communication and Collaboration is to provide a professional development experience and opportunity for community and networking within the Design Engineering Division (DED) of ASME that supports and mentors members of underrepresented groups. The workshop is designed to provide graduate students, faculty members, and industry members from underrepresented groups with professional development activities and to give them the opportunity to make connections with an international network of supportive researchers in their field. In addition to skill development, this workshop will support the development of a network of people within the community from underrepresented groups. This workshop will be the tenth annual workshop event of the Broadening Participation Committee of the ASME DED.

The focus of this workshop is to help attendees leverage their own knowledge, skills, strengths, and diversity to become a more effective collaborator and communicator. Attendees will learn skills to manage team dynamics, organize teams using a leadership model appropriate to the team composition and goals, and deploy effective communication strategies to manage collaboration and conflict within teams. Attendees will receive a free code to complete the Gallup Strengths Finder assessment before the workshop, and, during the workshop, will reflect on their individual strengths in the context of professional collaboration and communication.

Presenter: Mary Lynn Realff
Georgia Institute of Technology

Presenter Biography:

Mary Lynn Realff is an Associate Professor of Materials Science and Engineering at Georgia Institute of Technology (Georgia Tech). She received her B.S. Textile Engineering from Georgia Tech and her Ph.D. in Mechanical Engineering and Polymer Science & Engineering from the Massachusetts Institute of Technology (MIT). At Georgia Tech, Dr. Realff teaches graduate and undergraduate courses in the mechanics of textile structures and polymer science areas. She has made a significant contribution to the understanding of the mechanical behavior of woven fabrics.

Dr. Realff is the Associate Chair for Undergraduate Programs in the School of Materials Science and Engineering at Georgia Tech and a Co-Director of the Center for the Study of Women, Science and Technology. She also facilitates a student/industry mentoring program which matches industry mentors with Georgia Tech undergraduate students for nine month mentoring relationships. The program has been shown to increase the retention of students. Dr. Realff is a Fellow and a member of the Board of Governors of the American Society of Mechanical Engineers. She is a Gallup Certified Strengths Coach, on the board of the Center for Puppetry Arts in Atlanta, and volunteers at Inman Middle School (directing the GEMS girls' science club) and at Buckhead Church.

Expected Background of Participants:

There are no required or expected areas of experience or knowledge or expertise. Participants will likely be a diverse group of individuals at all points in their careers, from many different specialties.

Expected Audience

This workshop is aimed at attracting faculty, postdocs, Ph.D. students, M.S. students, administrators as well as engineers from industry. The selection process will strive to select a diverse set of participants from underrepresented groups, as well as others interested in the topic.

Need for the Workshop or Tutorial

The goal of the Broadening Participation Committee is to develop, implement, and oversee new and existing activities aimed at broadening the participation of women and underrepresented minorities in the activities of the Design Engineering Division of the American Society of

Mechanical Engineers. This workshop will be the tenth workshop event of the Broadening Participation Committee. In previous years, this workshop has been supported through funding from the ASME DED Executive Committee and the National Science Foundation. The committee intends to seek similar funding to support student travel and speaker fees for this workshop. It's often difficult to feel part of the ASME DED community, especially for under-represented members in engineering. In addition, when compared to majority group members, underrepresented members of a group do not receive as much informal mentoring that supports professional development. This workshop will enhance the feeling of community among members of the ASME DED and provide valuable professional development skills.

Impact:

This workshop will continue the efforts of the Broadening Participation Committee to support the development of a community feeling within ASME DED. In addition, volunteers from among workshop attendees will be solicited to join the committee to support additional committee activities in the coming years.

Course Outline

1:00PM–4:00PM Workshop on Effective Team Dynamics and Team Communication

- Introduction to Strengths Finder
- Building Awareness of our own Strengths
- Diversity in Teams
- Crucial Conversations for More Effective Communication
- A Tool to Take Home

4:00PM–5:00PM Panel of Experts from DED Community related to communication and team collaboration

5:00PM–6:00PM Introduction to ASME Design Engineering Division & social

5:00PM–5:05PM Introduction

- Describe Broadening Participation Committee mission/objective. Introduce each ASME DED technical and other committee chairs and the chair of the Design Engineering Division.

5:05PM–6:00PM Social – Interact with Technical Committees and Design Engineering Division Executive Committee (with refreshments)

6:00PM–6:30PM Social – continue discussions for those that can stay.

Workshop 6 — Technology Forecasting for Engineering Design

August 18, 2019
9:00AM–5:00PM
San Simeon B, 4th Floor

Organizers

Dan McAdams
Texas A&M
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Douglas Allaire
Texas A&M
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Richard Malak
Texas A&M
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Abstract:

Technologies evolve over time. Light bulbs become more efficient. Mobile phones become smarter. Also, new advances in enabling technologies such as LEDs lead to new disruptive technologies at the system level. Understanding when and how a technology is going to improve is crucial to designers, R&D managers, investors, and policy makers. Forecasting future technology performance is faced with many challenges. Many elements are involved in a technology performance evolution including investment in a technology, investment in a competing technology, and technology interactions.

In this workshop we provide a short overview of technology forecasting and present several fundamental methods for aiding the technology forecaster in a design context. The general scenario of technology forecasting will be presented in the face of technology performance change. A key element of technology forecasting in engineering design is decision-making. Basic and fundamental methods in decision-making under uncertainty will be presented and discussed. To further aid the design maker, methods of uncertainty quantification will be presented and discussed. Methods for modeling technology evolution and predicting future performance will be presented and discussed. In each case, the methods presented include those used in practice and emerging methods coming from the research community.

Presenter Biographies:

Daniel A. McAdams is the Robert H. Fletcher Professor in Mechanical Engineering Department of Mechanical Engineering at Texas A&M University. He received his Ph.D. from the University of Texas at Austin. Dr. McAdams's expertise is in the area of design theory and methodology with specific focus on functional modeling, innovation in concept synthesis, biologically inspired design methods, inclusive design, and technology evolution as applied to product design. He has edited a book on biologically inspired design. His work in technology evolution has been recognized by ASME with a best paper award.

Richard Malak is the Gulf Oil and Thomas A. Dietz Career Development Associate Professors of Mechanical Engineering at Texas A&M. Dr. Malak was the National Science Foundation Engineering Design and Systems Engineering Program Director from August 2016 to January 2019. He has expertise in principles, methods, and tools for systems modeling and decision-making. His specific focus is on quantitative methods for evaluating alternatives in the early phases of systems design. Specific applications include predictive modeling, multi-attribute decision-making, data-driven design evaluation and synthesis, model validation, set-based design, decision-making under uncertainty, cyber-physical systems, and computational thinking applied to design processes.

Douglas Allaire is an assistant professor in Mechanical Engineering at Texas A&M. He is the Sallie and Don Davis '61 Faculty Fellow. Dr. Allaire received his Ph.D. in Aerospace Engineering from the Massachusetts Institute. His expertise is in computational design methodologies with an emphasis on uncertainty quantification and optimization. Dr. Allaire received the American Society of Mechanical Engineers Computers and Information in Engineering

Young Engineer Award in 2018. His work in uncertainty quantification has been recognized with a best paper award.

Expected Background of Participants:

There are no required or expected areas of experience or knowledge or expertise.

Expected Audience

Industry engineers, engineers in government, engineers in research groups, policy makers, new product investors, graduate students, faculty, technical managers.

Need for the Workshop or Tutorial

Innovation is critical to the social welfare, health, economy, and security of the USA and the world. A fundamental understating of innovation is elusive. Innovation can be observed, but it is hard to predict, and harder to execute. Though innovation and technology performance evolution over time are not one and the same, they are intimately tied together. A better understanding of technology evolution can benefit decision makers, designers, and engineers.

Impact:

Better understanding of future technology performance informs decision-making. The material presented in this workshop is new and emerging methods to understand technology evolution.

Course Outline

9:00AM–12:00PM Overview of Technology Forecasting
Elements of Technology Forecasting, including Adaption, Diffusion, and Disruptions
- Overview of Technology Forecasting
- Technology Ecosystems
- Decisions in Technology Forecasting
- Decision Theory
- Decision Making Under Uncertainty
- Emerging Methods in Decision Making

12:00PM–2:00PM Break

2:00PM–5:00PM Uncertainty Quantification
- Background and Mathematical Foundations
- Traditional Methods
- Emerging Methods
- Technology Performance Evolution
- Traditional Predictive Models
- Cases
- Emerging Predictive Models
- Bounding Model Accuracy

Workshop 7 — Problem of Minds: What the Octopus Teaches Us

August 18, 2019
1:00PM–5:00PM
Huntington A, 4th Floor

Organizer

Shuichi Fukuda
Tokyo Metropolitan Institute of Technology (retired)
shufukuda@gmail.com

Abstract:

As the phrase “Make up your mind” indicates, Mind plays an important role in our decision-making. Most of us think Mind is Brain, and we make decisions based on knowledge. But the Octopus does not have such a large brain and it does not transfer experience from generation to generation, because parent octopuses die soon after their babies are born. So, to them, Mind is Body.

The octopus is on the opposite side of the evolution tree from humans, but their behaviors are very wise. They interact with the outer world directly with their eight arms and make wise decisions. They may be called Masters of Adaptability.

As changes occur frequently and extensively in an unpredictable manner, adaptability becomes more important than product functions. And our knowledge, which is structured pieces of past experience, would not work anymore. Then, we could learn how we can interact directly with the outer world from the octopus. We may be able to perceive the situation correctly, make decisions adequately, and immediately to respond to the changes and adapt to the new situation.

Fukuda first explains the difference of humans and the octopus. Then we all discuss how we could possibly interact with the outer world more directly and more wisely and what benefits that would bring us.

Presenter Biographies:

Shuichi Fukuda is, in a word, Multidisciplinary Researcher (MR). He received Dr. of Eng from University of Tokyo in 1972. He developed a fatigue testing machine for vehicles under random loading. So, his research was associated with dynamics, strength of materials, and reliability. And the application includes all kinds of vehicles. Then, he worked at Department of Precision Machinery, University of Tokyo and developed nonlinear FE programs. Then, he moved to the Welding Research Institute, Osaka University and worked on intelligent production. During these years, he worked concurrently with the Robotics Institute, CMU and engaged in the DICE Project at WVU. As welding is used in many different fields, he worked together with civil, shipbuilding, air, nuclear, automotive, NDI, etc., engineers. Before he moved to Tokyo Metropolitan Institute of Technology (TMIT), he worked at the Institute of Industrial Science, University of Tokyo concurrently in pursuit of making industry more resiliently intelligent. At TMIT, he worked at the department of information, production and systems engineering. He served dean of engineering, dean of library and information systems, and concurrently 1st director of Industry-Academia-Government Collaboration Center for Tokyo Government and worked concurrently at WVU, Osaka University, Open University of Japan (OUJ), and Cranfield University, UK and Stanford University, as visiting professor. After retirement from TMIT, he worked as Consulting Professor at Stanford, as visiting professor at OUJ, and as part-time member of Japanese Government at the Science Council of Japan. Since 2014, he has been working as advisor at Systems Design and Management Research Institute, Keio University, Japan.

Personally, he played on a soccer team as a midfielder when he was young. When he played, soccer was 11 Best, but soccer today is Best 11 (Knute Rockne). We need sensing and communication capabilities to make up the best team today. The Octopus is known as master

of adaptability. I hope we can learn from them how to adapt.

Expected Background of Participants:

Expected Audience

Anyone, who is interested in this topic and who will join the discussion. Short presentation (about 5 minutes) is welcome.

Need for the Workshop or Tutorial

Engineering has progressed remarkably, but it was based on rational, explicit approaches.

Let me explain this way. How do you identify the name of a river? If you look at the river itself, you cannot. Water is changing every minute. So, you look around and find mountains or forests that do not move and identify its name.

System identification is the same idea. If some parts of a system do not follow rational rules, we look around and find feature parts which follow rational rules. So, we could expand the rational world into the controllable world.

But the world is expanding very rapidly, and diversification and personalization are also increasing at a surprising speed. In other words, we are now thrown into the flow and we need to swim. As Woodrow Wilson said, "The man who is swimming against the stream knows the strength of it." We need to swim against the flow to survive.

Engineering needs a big revolution for us to survive in this rapid flow. We should interact with the outer world more directly and more intuitively. We can no longer rely on the past experience. We need to design a new experience in order to survive. We should shift from Knowledge to Wisdom.

Impact:

IoT is changing our world quickly and extensively and creating a new world "World 2.0," where man and machine work together on the same team. Man used to be outside of the system and give instructions to machine. And machine responded. But now man needs to be in the system as a playing manager.

In other words, we could be on the bank and watch the river, but now we are thrown into the river and to reach to this new World 2.0, we need to develop capabilities to swim up against the river. Otherwise, we will be carried away.

This relates to the problem of human motion and motor control. We coordinate our body parts and regulate our movements. This is another problem of developing an adaptive network without any substantial rules about the game. We need to perceive and understand the situation correctly in a short time to adapt to the changes. Direct and tangible interaction with the outer world is called for.

It is hoped that this workshop provides an opportunity to reconsider engineering fundamentally and to contribute to the development of the fruitful and rewarding World 2.0.

Course Outline

First, Fukuda presents how humans and the octopus are different in interacting with the outer world and what benefits the Octopus way of direct and tangible interaction have. Then, if some participants would like to make a short presentation, these will follow.

After these preliminary presentations, we all discuss how we can secure direct and tangible interaction. It is hoped that these discussions will lead us to make adequate decisions without time delay and will tell us what benefits we can expect from direct and tangible interaction.

In short, we will discuss how we can add natural intelligence to artificial intelligence.

Workshop 8 — Complex Parts Intelligent Manufacturing

August 18, 2019
1:00PM–6:30PM
Huntington B, 4th Floor

Organizer

Neng Wan
Northwestern Polytechnical University
wanneng@nwpu.edu.cn

Abstract:

Evolution of new process is changing the production fabrication. More complex structure, higher quality, and more convenient operation requirements put forward a challenge to the intelligent and lean manufacturing. Discovery of the geometry principles in, fabrication process became a hotspot in CAD/CAM domain. The goal of the workshop is to discuss the geometry principle and methodology in modern research concerning CNC machining, 3D print, augmented reality (AR), large-scale metrology and on-machine inspection, etc. First, we present recent developments of using multi-axis motion to conduct material accumulation in 3D print, as well as a few future extensions about reinforcement of 3D printed parts. As we go along, we talk about the large-scale metrology in the aero-space region. Some key technologies regarding automation, data processing, and their application in industry will be introduced. Next, this workshop provides an introduction of two case studies using AR to enable smart manufacturing. We encourage brainstorming of possible AR applications. Furthermore, a method of utilizing geometry principle for milling of bevel gear will be presented, which is the guidance of tool path planning. At last, we present a study about multi-axis on-machine inspection for impeller, where new exciting methods will be shared with the audiences. We highly encourage interested scholars and experts to attend our workshop.

Presenter Biographies:

Jun Wang is a professor and doctoral supervisor of Nanjing University of Aeronautics and Astronautics. He received his B.S. and Ph.D. degrees from Nanjing University of Aeronautics and Astronautics in 2002 and 2007. From 2008 to 2010, he worked as a postdoctoral researcher in University of California and University of Wisconsin. From 2010 to 2013, he worked as a research and development team leader at Leica Geosystems, where he led the research and development of ultra-large-scale 3D data processing, analysis, management, and visualization. In 2013, he went to Harvard University for research visits and research cooperation and he joined Nanjing University

of Aeronautics and Astronautics, appointed as the fourth batch of Jiangsu Distinguished Professors. In 2015, he was selected as a young talent in the "1000 Talents Plan" of the Organization Department of the Central Committee of the CPC. His research interests include digital measurement and data processing, large-scale point cloud data processing, and analysis, etc.

Chih-Hsing Chu is a Professor in the Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Taiwan. He attended National Taiwan University and received his B.S. and M.S. degrees from the Department of Mechanical Engineering. He received his Ph.D. degree in mechanical engineering from the University of California, Berkeley, USA. His past work experiences include Web Applications Engineer at RedSpark, an Autodesk Venture, USA, DaimlerBenz AG, Germany, and a visiting researcher at the Laboratory for Machine Tools and Production Engineering (WZL), RWTH Aachen, Germany. Prior to joining National Tsing Hua University in 2002, he was an Assistant Professor in the Industrial and Systems Engineering Department, Virginia Tech, USA. He was an invited scholar at CREDITS Center, Sungkunkwan University, Korea, during the summer of 2005. His research interests include digital manufacturing, CAD/CAM, augmented reality, and collaborative engineering. He is a member of IEEE, ASME, and SME.

Shengjun Liu is a professor of School of Mathematics and Statistics, Central South University. In September 2007, he graduated from the State Key Laboratory of CAD&CG of Zhejiang University with a Ph.D. In July 2007, he entered the School of Mathematics and Statistics of Central South University. In December 2011, he was selected into the Sublimation of Elite Talents Program t of Central South University. In July 2012, he was selected as a doctoral tutor and promoted to professor at the School of Mathematics and Statistics of Central South University in March 2014. He conducted an academic visit at the Department of Mechanical and Automation Engineering at the Chinese University of Hong Kong from November 2007 to October 2008 and from July 2009 to August 2010. And he worked in postdoctoral research at the Department of Computer Science at Chemnitz University of Technology in Germany from January 2012 to April 2013.

Yuansheng Zhou is a lecturer in the Department of Vehicle Engineering of the School of Mechanical and Electrical Engineering of Hunan University. In 2011, he graduated from Harbin Engineering University with his B.S and M.S degrees. In 2015, he received his Ph.D. degree from Concordia University in Montreal, Canada. His interests include gear design, manufacturing and simulation, complex surface intelligent manufacturing, CNC machining, CAD/CAM/CAE and automotive lightweighting, and body building. He has published several high-level academic papers in journals such as *Computer-Aided Design*, ASME, *International Journal of Machine Tools and Manufacture and Mechanism and Machine Theory*.

Neng Wan graduated from the Northwestern Polytechnical Unversity with a Ph.D. He is interested in the technologies of computer-aided manufacturing. In recent years, he focuses on the research about on-machine inspection and laser processing. He has published more than 20 research papers and has written more than three teaching materials as the main editors.

Expected Audience

This workshop addresses graduate and undergraduate students, engineers from industry, as well as scholars interested in CAD/CAM domain, professionals working in related areas such as CNC machining, 3D print, augmented reality, large-scale metrology and on-machine inspection, etc.

Course Outline

1:00PM–1:40PM Surface reconstruction from 3D point cloud with data-driven exemplar priors
- 3D models are reconstructed from raw scanned points by learning the prior knowledge.
- A comprehensive library of 3D local shape priors are sufficient to represent the 3D shapes.

1:40PM–3:20PM Augmented reality assisted smart manufacturing
- An AR interface to improve the efficiency and precision of programming
- A novel AR application that guides a human operator to accomplish a manual grinding operation

3:20PM–4:00PM Implicit modeling of adaptive wireframe structures for scalable fabrication
- An implicit modeling method of adaptive wireframe structures for scalable fabrication
- A streaming slicing strategy is adopted to achieve scalable fabrication.

4:00PM–4:40PM An efficient method of five-axis flank milling of spiral bevel gears with a filleted end mill cutter
- The contact area is accurately machined by the cutter flank side with a tangency condition.
- A filleted end mill cutter is used to cut each side of a tooth surface with one pass.

4:40PM–5:20PM High accuracy on-machine inspection based on rotation theory.
- A rotation theory is investigated for balancing efficiency and accuracy
- The least rotations, the least direction reversions of the rotary axes are obtained

Workshop 9 — Teaching Scrum for Hardware/ System Design

August 18, 2019
1:00PM–6:30PM
Palos Verdes B, 4th Floor

Organizers

David G. Ullman
Emeritus, Oregon State University
ullman@davidullman.com

Joshua Tarbutton
University of North Carolina at Charlotte
Joshua.tarbutton@uncc.edu

Abstract:

The Scrum Agile framework is widely used in software design and has recently been adopted by many non-software industries such as Tesla, John Deere, Saab Aerospace, Raytheon, Oak Ridge National Labs, Bosch, Plantronics, SpaceX, and many others. This workshop will explore the benefits and challenges

of teaching Scrum to mechanical, electrical, mechatronic, and systems engineering students.

While it is absolutely essential for hardware systems to be planned and be sequential from needs to concepts, to product to manufacturing, real-world uncertainty forces much nonsequential effort that cannot be ignored. Scrum well fits into the serial process allowing "planning in the small" to manage uncertainty and change. It also fosters collaboration, communication, and product design quality.

Included in the workshop will be a free copy of the 2019 ebook, "Scrum for Hardware Design." This 84-page ebook contains the thirteen basic steps to apply the Scrum methodology to the design of hardware and systems.

This book also includes two case studies: one based on a student design project from Olin College and the other on how Saab Aerospace uses Scrum to design world-class fighter aircraft.

Another feature is the appendix describing how hardware design and software design differ when using Scrum. This will be helpful for multidisciplinary teams.

Also included in the workshop is an instructors' manual. This includes:

- The reasons to include Scrum in your courses
- Learning objectives in an ABET format
- Resources for teaching scrum as part of your courses on design methods, mechatronics, the capstone experience, or other course that has a design process element.

This instructor's manual will be the backbone of the workshop as it contains methods for teaching and evaluating each of the elements of the Scrum framework.

Presenter Biographies:

David G. Ullman is an active product design and has trained over 5000 students how to develop products from need to delivery. In 1992 he published "The Mechanical Design Process," a text now in its 6th edition that is used internationally and has been translated into Chinese and Korean. It is a compendium of best design practices. In 2019 he published "Scrum for Hardware Design," bringing new design best practices to students.

Dr. Ullman holds a Ph.D. from The Ohio State University and is an ASME Life Fellow and Emeritus Professor from Oregon State University. He is a DTM founder. He holds six patents and is an active product designer, aerospace engineer, and product design consultant. He is a certified Scrum master. He lives at an airpark where he designs, builds, and flies airplanes.

Joshua Tarbutton's research is focused on exploring how innovative geometrical and process solutions can solve bottlenecks that exist between design and manufacturing. His primary focus is on how tool path generation in the 3D scanning, reverse engineering, and machining processes can be automated to increase productivity during manufacturing of discrete parts. He also is investigating additive manufacturing of piezoelectric polymers and was the first researcher to create piezoelectric polymers during 3D printing using the EPAM method he invented. Dr. Tarbutton received a B.S. degree in Mechanical Engineering from the Georgia Institute of Technology in 2005. He received his M.S. degree and his Ph.D. both in mechanical engineering from Clemson University in 2007 and 2011, respectively. He spent a year at IST Precision as an industry postdoctoral fellow under the ASEE-NSF Small Business Research Diversity Fellowship. He took a post as an assistant professor at USC in Columbia, SC in 2012 where he remained until 2016 when he moved to UNCC in Charlotte, NC. He has won two teaching awards, published 50 papers, holds a patent in displacement metrology, and is an Army Veteran. He owns Bravo Team, an engineering design and product development firm of seven engineering wizards who spend their days helping people make things. He is a certified Scrum Master and practices SCRUM with his research group and his senior design teams at UNCC and his staff of wizards at Bravo Team LLC.

Expected Background of Participants

There are no required or expected areas of experience or knowledge or expertise. Participants will likely be a diverse group of individuals at all points in their careers, from many different specialties.

Expected Audience

This workshop is aimed at attracting faculty, postdocs, Ph.D. students, M.S. students, administrators, as well as engineers from industry.

Need for the Workshop or Tutorial

While the Scrum design process has been widely adopted in software design, it is only recently beginning to be used for hardware projects and systems. Few are currently teaching the methods in the classroom, yet curiosity is high about exactly what Scrum is and how to teach it. This workshop addresses answers:

1. What is Scrum?
2. What has been its impact in software development?
3. How does this impact reflect in hardware and systems design?
4. How can Scrum best be taught?

Impact:

This workshop has the potential for changing how students (and faculty) view the design process.

Course Outline

1:00PM–2:00PM The history of scrum and its impact in software development

2:00PM– 3:00PM Scrum at 30,000 ft – What is it?

3:00PM–3:15PM Break

3:15PM–6:30PM Hands on doing the 13 steps of Scrum. The participants will be divided into teams and then guided through the steps. This process is exactly what they can do with their students.

Tutorials

Tutorial 1 — Learning Topology Optimization Through Examples and Case Studies

August 18, 2019
9:00AM–4:30PM
Capistrano A, 4th Floor

Organizers

Krishnan Suresh
University of Wisconsin-Madison
ksuresh@wisc.edu

Amir M. Mirzendehdel
Palo Alto Research Center
amirzend@parc.com

Abstract:

The objective of this workshop is to expose the audience to cutting-edge topology optimization techniques. Strategies for posing and solving multi-load, multi-body topology optimization problems will be presented. Recent developments in integrating topology optimization and additive manufacturing will also be discussed.

Presenter Biographies:

Krishnan Suresh is the Philip and Jean Myers Professor of Mechanical Engineering at the University of Wisconsin-Madison. He received a Master's in Manufacturing Engineering from UCLA in 1992, and a Master's and Ph.D. in Mechanical Engineering from Cornell in 1994 and 1998, respectively. He later served as an Engineering Manager at Kulicke and Soffa Industries, Philadelphia from 1998 to 2002.

He has received numerous peer-reviewed grants, including the prestigious NSF Career award. His research interests include topology optimization, additive manufacturing, advanced finite element analysis, and high-performance computing. He has co-authored over 75 peer-reviewed papers, two of which have received best-paper awards from ASME. He has also authored two textbooks on applied optimization.

He is the founder of SciArt, LLC (www.sciartsoft.com), a UW-Madison spinoff that creates and supports high-performance topology optimization software solutions.

Amir M. Mirzendehdel is a Research Scientist at the Palo Alto Research Center (PARC). He earned his Ph.D. and M.Sc. degrees in Mechanical Engineering from the University of Wisconsin-Madison and his B.Sc. in Aerospace Engineering from the Amirkabir University of Technology (Tehran Polytechnic), Iran.

His research focuses on large-scale finite element analysis and topology optimization for additive manufacturing. He has co-authored the book, "A Hands-on Introduction to Topology Optimization" with Dr. Suresh, which provides a working knowledge on the field of topology optimization.

Expected Background of Participants:

The primary audience includes senior undergraduate students, graduate students, faculty, and practicing engineers. Given this wide audience, no prior background in topology optimization is assumed; a working knowledge of finite element analysis (FEA) is however helpful. The primary objectives are to introduce the readers to topology optimization terminology, discuss and illustrate various sensitivity analysis techniques (that form the backbone of any topology optimization method), and provide numerous examples and case-studies to illustrate the merits of topology optimization. While Pareto is used in this workshop to illustrate the main concepts, the attendee can later use any topology optimization software that is capable of handling the problems.

Expected Audience

The primary audience include senior undergraduate students, graduate students, faculty, and practicing engineers.

Need for the Workshop or Tutorial

Topology optimization (TO) is an exciting method for generating insightful and creative designs. The objective of this workshop is to offer a hands-on introduction to topology optimization, by juxtaposing theory with examples and casestudies. Over the past several years, additive manufacturing (AM) has emerged as a promising alternate to subtractive methods.

AM refers to a class of manufacturing processes through which parts are fabricated by material addition. The growing interest in AM stems from its ability to fabricate highly complex parts, with minimal effort. AM and TO complement each other in that organic and complex designs generated through TO can be easily manufactured through AM. Despite the obvious synergy, there are several challenges that need to be addressed before TO and AM can be seamlessly integrated. Some of these will be discussed during the workshop.

Impact:

This workshop will teach graduate students and engineers the basics of topology optimization so that they can proceed to apply and advance the technology.

Course Outline

Morning Session
- Overview of topology optimization
- Example 1: Posing and solving a simple structural optimization problem
- Example 2: Restraints and loads
- Example 3: Stress and displacement constraints
- Example 4: Design constraints
- Example 5: Multi-load problems
- Example 6: Multi-body problems
- Exercises

Afternoon Session
- Example 7: Design iterations
- Example 8: Body forces
- Example 9: Thermo-elastic topology optimization
- Case study: GE-GrabCAD design optimization
- Case study: Alcoa-GrabCAD design optimization
- Design challenge
- Topology Optimization and Additive Manufacturing: Challenges and Opportunities

Tutorial 2 — Structronic Systems and Precision Actuations

August 18, 2019
1:00PM–5:00PM
Capistrano B, 4th Floor

Organizers

Hornsen (HS) Tzou
Nanjing University of Aeronautics and Astronautics
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Mu Fan
Nanjing University of Aeronautics and Astronautics
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Abstract:

The synergistic integration of smart materials, structures, machines, sensors, actuators, and control electronics transforms conventional passive structures and machines to active, adaptive, and "smart" structronic (structure + electronic) or mechatronic systems with inherent self-sensing, diagnosis, and control capabilities. Research and development of the emerging technology of smart structures and structronic systems have been evolving for over three decades. Sophisticated multi-field/control coupling theories have been developed, and numerous practical applications have been proposed and utilized. This report focuses on histories, smart materials (e.g., piezoelectrics, ferroelectrics, electro-/magneto-/photo-strictive materials, shape memory materials, electro- and magneto-rheological fluids, polyelectrolyte gels, pyroelectric materials, magneto-optical materials, superconductors, etc.), precision devices (sensors and actuators), micro-/nano-actuations, smart structures, mechatronic and structronic systems, and photo-thermo-electro-magneto-mechanical systems encompassing elastic, temperature, electric, magnetic, light, and control interactions. Modern research issues are also discussed.

Note: Registration for this workshop is being handled separately from the main conference registration. If you are interested in attending this workshop, select it during your conference registration process. However, you MUST also complete the survey.

Presenter:

Hornsen (HS) Tzou is the Director of the Interdisciplinary Research Institute of Aeronautics and Astronautics in the College of Aerospace Engineering at Nanjing University of Aeronautics and Astronautics (NUAA) (09/2015– present), the 1st-round Fellow and National Professor of the 1k-Talent Program of China, an ASME Fellow (1996), Professor Emeritus at the University of Kentucky, and a Chair-Professor (03/2016–06/2019) at Zhejiang University. He joined Zhejiang University (09/2009–12/2015) after nearly 30-year service at the University of Kentucky (Department of Mechanical Engineering). He earned his M.S. and Ph.D. from the School of Mechanical Engineering at Purdue University in 1979 and 1983, respectively. He was among the pioneers in "smart structures and structronic systems." His research and teaching interests encompass smart structures and structronic systems, precision mechatronics, hybrid multi-functional piezo/photo/flexo/megneto/electro/elastic structures, design, and micro actuation of biomedical devices and tools, dynamics, and distributed sensing/control of discrete and distributed systems (shells, plates, etc.), nonlinear joint/contact dynamics and control, electromechanics, opto thermopiezoelectric devices and systems, etc.

He was invited and worked at IBM (CAD/CAM and Printer R&D), Wright Laboratory (Flight Dynamics Lab), the Institute of Space and Astronautical Science (ISAS) (Japan), Tohoku University (Japan), the Otto von Guericke University of Magdeburg, German Aerospace Research Establishment (DLR) (Braunschweig, Germany), Amway Research R&D, Tokyo Institute of Technology (Japan), NASA Levis, Harbin Institute of Technology (China), National Taiwan University (NSC Chair Professor), etc. He directed the StrucTronics and Design Lab (founded by NSF, JPL, ARO, NASA, AFOSR, Pratt-Whitney, IBM, Ford, industries, etc., since 1985) at UK till his retirement.

Dr. Tzou has won several ASME/AIAA Best Paper Awards, NASA Class-1 New Technology Disclosure Awards, six ASME Service Awards, etc. He has authored and co-authored over 500 technical publications. He also authored *Piezoelectric Shells (Sensing, Energy Harvesting and Distributed Control)* (two editions), *Design of Smart Structures, Devices and Structronic Systems,* and edited seven other books. He served as chair (07/2012–11/2014) and deputy (11/2008–06/2012) of the ASME Board on Technical Knowledge Dissemination (BTKD), Executive Member of Technical Communities Operating Board (TCOB) and Chair of ASME Interdisciplinary Councils (11/2008–06/2012), a founding member of the ASME Adaptive Structures and Material Systems Committee (11/1990), the General Chair of the 2007 ASME International Design Technical Conferences and Computers & Information in Engineering Conference (IDETC/CIE), the Conference Chair of the 21st Mechanical Vibration and Sound Conference, Co-chair of the 23 International Conference on Adaptive Structures Technologies, etc.

Expected Background of Participants:

Basic mechanical engineering background would be fine. Common knowledge of smart materials, smart structures, and structronic systems would help, but not necessary.

Expected Audience

This workshop is aimed at design engineers, faculty, postdocs, PhD/MS students, etc., who are interested in precision actuations and design applications of smart materials and structronic systems.

Need for the Workshop or Tutorial

This workshop/tutorial, along with panel discussions, was first offered at the 1999 Design Engineering Technical Conferences (DETC) in Las Vegas. It has been offered, almost, biannually at the IDETC till 2011 and its short version has been presented numerous times, including a Plenary Keynote at the 2017 IMECE. As the area keeps growing significantly over the years, there is

a need to update the technology, especially in precision actuations and design applications, and to introduce to the younger generation.

Impact:

The "smart materials, smart structures, and structronic systems" technology has been vigorously developing in three decades. This tutorial/workshop would continue the longtime tradition and continue the efforts of introducing practical design applications in high-precision actuation and control of mechanical systems.

Course Outline

1. Introduction and overview
2. Smart materials: piezoelectrics, flexoelectrics, electro/magneto-strictive materials, shape memory materials, electro/magneto rheological materials, polyelectrolyte materials, photostrictive materials, pyroelectric materials, magneto-optical materials, superconductors, etc.
3. Design principles, micro-/nano-actuations, precision devices and control
4. Case studies
5. Design clinic: Special and customized applications

Tutorial 3 — Designing, Prototyping, and Programming Robot Motions Using MotionGen and SnappyXO

Aug 18, 2019
1:00PM–4:00PM
Palisades, 4th Floor

Organizers

Anurag Purwar
Stony Brook University
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Shrinath Deshpande
Stony Brook University
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Shashank Sharma
Stony Brook University
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Abstract:

This workshop will demonstrate a state-of-the-art app called MotionGen for designing and simulating planar linkages and a novel robot kit called SnappyXO for rapid prototyping of the robot motions and structures. The app and the robot kit are being used in Freshman Design Innovation, undergraduate and graduate Kinematics class at Stony Brook University.

SnappyXO robot kit is a low-cost, modular, and innovative kit, which allows structural prototyping of robot chassis and their motions. It works with off-the-shelf electronics, open source software, and employs an open architecture to allow users to design and make their own parts.

Attendees will be able to take home the robot kit used in the workshop.

Presenter Biographies:

Anurag Purwar is a Research Associate Professor of Mechanical Engineering at Stony Brook University and the primary inventor and creator of the SnappyXO robot kit and MotionGen app. His research and teaching interests are in Mechanisms and Robotics, Kinematics, and CAD/CAM. He has received several best paper, teaching, and design innovation awards.

His research has been funded by National Science Foundation (NSF), NY-state SPIR, NY-state Center for Biotechnology, Sensor-CAT, SUNY Research Foundation, industry, Stony Brook University, and SUNY Office of Provost.

He has been twice elected as a member of the ASME Mechanisms and Robotics Committee and served as the Program Chair for the 2014 ASME Mechanisms and Robotics Conference, as the Conference Chair for the 2015 ASME Mechanisms and Robotics Conference and has served as symposium and session chairs for many ASME International Design Engineering Technical Conferences. He was the general Conference Co-Chair for the 2016 ASME International Design Engineering Technical Conferences (IDETC/CIE).

Prof. Purwar is currently an Associate Editor of the *ASME Journal of Computing and Information Science in Engineering* and of the I*nternational Journal of Mechanics Based Design of Structures and Machines*.

Shrinath Deshpande and **Shashank Sharma** are senior Ph.D. students of Prof. Anurag Purwar, who will be assisting him with this workshop. Their research is in the mechanisms and robotics area and leveraging machine learning to machine design problems.

Expected Background of Participants:

Participants are expected to have at least a basic understanding of planar linkages. Participants will need to bring a computer with a working internet connection. This will be a hands-on workshop leading participant to the design of linkages using MotionGen and then prototyping them using the SnappyXO robot kit.

Expected Audience

Professors teaching design innovation, kinematics, mechatronics, students interested in these subjects, and industry practitioners looking to rapidly prototype their motion ideas will benefit from this workshop the most.

Need for the Workshop or Tutorial

There are practically no motion synthesis tools out there and the leading, commercially available robot kits are expensive. In addition, they do not provide any significant design exposure to the students. The framework presented in this workshop will allow participants to learn how to virtually and physically design and prototype linkages for creating robot motions.

Impact:

This workshop exposes students to hands-on experience designing, prototyping, and programming machines, which would help achieve the NSF's mandate to support development of a strong STEM workforce and help fill the 2.4 million STEM jobs that are vacant according to the current Bureau of Labor Statistics.

Course Outline

1. Introduction to MotionGen
   1. 1. Design and Simulate Planar Linkages: Hands-on Exercises
2. Introduction to SnappyXO Robot Kit
   2.1 Design and Build Simple Geometry: Hands-on Exercises
   2.2 Design and Build a Simple Non-Motorized Contraption: Hands-on Exercise
   2.3 Design and Build a Linkage-Based Walking Robot Driven by Motors: Hands-on Exercise
   2.4 Pointers on Robot Programming Using Open Source Microcontrollers, Such as Arduino family.

Tutorial 5 — Tutorial on Multibody Flexible Robot Design

August 18, 2019
2:00PM–6:00PM
Oceanside, 4th Floor

Organizers

Mariapaola D'Imperio
Istituto Italiano di Tecnologia
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Khelifa Baizid
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Ferdinando Cannella
f Istituto Italiano di Tecnologia
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Abstract:

The 5th Tutorial proposes a strategy that is more addressed to the Industry 4.0 new research challenges (mainly, Robotics, Simulation, Sensorisation, and Digital Twin) using virtual prototyping techniques. This year, the topic will be based on the integration between mechanics and control in the development process of industrial robots. It focuses on the development of a flexible robotic arm for pick and place operations in the packaging industry. Therefore, the development of a virtual prototype before the physical one has twofold advantages: the first one is the verification of both the mechanical and the control solutions are valid and good enough, and the second one is the possibility of generating a database of sensor measurements to compare with the one that registered from the physical robot. This last aspect fits with the requirements of the Industry 4.0 that aspires to the "conscious and intelligent factory": the new processes should involve even more control of the single operation parameters.

Note: Registration for this workshop is being handled separately from the main conference registration. If you are interested in attending this workshop, select it during your conference registration process. However, you MUST also complete the survey.

Presenter Biographies:

Mariapaola D'Imperio received her Master's Degree in Civil Engineer in 2011 from Polytechnic University of Marche, Ancona, Italy and Ph.D. in Robotics in 2016 from the University of Genoa, Italy. The principal subjects of her Master's degree were stability of structures, mechanic of materials and structures, and analytical structural analysis; while her PhD topic concerned the Modelling and Simulation Techniques for Advanced Robotic Systems. Actually she is a postdoc at the Italian Institute of Technology and her research interests are focused on the development of several multi-body-finite elements (MBM-FE) models able to interact with control algorithms, with the aim of promoting an integrated approach in the design of highly dynamic robotic systems. The research involves also the identification process of all the model parameters required to develop a reliable numerical model.

Khelifa Baizid received his B.Sc. and Engineering degrees in mechanical engineering from the University of M'hamed Bougara of Boumerds (Algeria) in 2001 and 2004, respectively. In 2007, he received his Master degree from the Polytechnic Military School. He got his Ph.D. degree (2010) in Robotics at the Italian Institute of Technology in collaboration with the University of Genova, Italy. He was a postdoctoral researcher at the Italian Institute of Technology in 2011, Genova, Italy, Brno University of Technology in 2012, Czech Republic, and the University of Cassino and Southern Lazio from 2013 to 2014, Cassino, Italy. He worked as a postdoctor for Mines Telecom Institute, Douai, France during 2015–2016, and currently, he is a postdoctoral researcher at the Advanced Industrial Automation Lab, Advanced Robotics Department at the Italian Institute of Technology, Genova, Italy. His research includes research on how to fit industrial requirements using robotics, reconfigurable mechanisms, and grippers.

Ferdinando Cannella received his first Ph.D. (University of Padua) in 2002 in "Mechanical Measurement applied to Engineering" with Thesis "Optical Measurement of strain: Application on Timing Belt" and his second Ph.D. (Polytechnic University of Marche) in 2006 in Mechanical Engineering with Thesis "Stiffness Modelling and Kinematic Analysis of Carton Handling and Manipulation with a Reconfigurable Mechanism using Numerical Simulation." He has long and wide experience in using the Computer-Aided Engineering tools for Co-Simulation (Multi-body, Finite Element, and Control) to investigate and to develop new robotic grippers or robotic manipulator systems or packaging mechanisms exploiting the bio-inspiration models. From 1998 to 2008, he taught Finite Element Model applied to dynamics embedded in the Course "Mechanics of Vibrations" and from 2005 he has been the tutor of the students.

From January 2005, he has been working at King's College of London, University of London as Post-doctor Visiting Researcher in the ARCHAPS (Automatic Reconfigurable Confectionary Handling and Packaging System) project. The aim of this collaboration is to improve the knowledge in carton crease behavior and folding reconfigurable mechanisms.

He joined in 2008 to Advanced Robotics Department lead by Prof. Darwin Caldwell at the Italian Institute of Technology; the topic is the Flexible Multi-Body Simulations applied to the development of Robot Manipulators, Packaging, and Biomedical Devices.

From 2015, he is head of Advanced Industrial Automation Lab and works in several projects focused in Industrial Automation with EU funding as AutoRECON and EuroC or with

several companies as GE AVIO, Tetra Pak, Fameccanica, Novacart, Ansaldo Energia, etc.

The main topics are:

- robotic grasping applied to the industrial manufacturing
- elasticity in robotic manipulators
- reconfigurable mechanisms
- numerical models of robotic systems

All the four research topics are initially approached by analytical techniques using numerical ones as multi-body simulations and finite element model.

From October, 2008 he worked as PostDoc Senior and from October 2010 he worked as a Team Leader at the IIT (Italian Institute of Technology) in the Department of Advanced Robotics with Prof. Darwin Caldwell. Since 2015 he has been responsible for the Advanced Industrial Automation Laboratory and works in several projects (both at national and European level) focusing mainly on industrial automation.

Dr. Cannella is the P.I. o Co-PI in Research Project, with companies such as Merloni, Dayco, GE Avio Group, Fameccanica, Tetra Pak, Ansaldo Energia, Novacart, etc.

Expected Background of Participants:

Basic knowledge of kinematics, dynamics, and linear controls.

Expected Audience

This workshop is addressed to faculty numbers, Ph.D. students, M.S. students as well as engineers from industry having research interests in the area of robotic design and control.

Need for the Workshop or Tutorial

The hands-on part of the tutorial consists of developing a Multi-Body model of a robotic arm by using MSC ADAMS software. For this reason, it is asked for the participants to bring with them their own laptop. A free license of the software will be available for all the attendees. In order to avoid losing time for the software installation phase, the participants should contact mariapaola.dimperio@iit.it to get the free license and to install the software in the weeks preceding the start of the conference.

Impact:

Participants will be fully trained to design complete robot limbs on their own.

Course Outline

2:00PM–2:15PM Workshop introduction

2:15PM–4:00PM Kinematic and Dynamic Multi-Body Model Development

4:00PM–4:15PM Break

4:15PM–6:00PM Flexible Multi-Body Model and Control

Tutorial 6 — Constructing Preference, Value, and Utility Functions in Engineering Design

August 18, 2019
9:00AM–1:00PM
San Clemente, 4th Floor

Organizer

Ali E. Abbas
University of Southern California
aliabbas@usc.edu

Abstract:

The goal of this workshop is to provide academics, students, and professionals with state-of-the-art methods for quantifying preferences to enable them to make better design decisions, and particularly when uncertainty is present. The workshop is interactive, with numerous practical demonstrations and exercises, and is designed to provide graduate students, faculty members, and industry professionals with an opportunity to ask challenging questions about the implementation of rigorous decision-making methodologies in engineering design. The workshop will also highlight some of the common misuses of decision analysis in engineering design. In addition, the workshop will help provide networking opportunities and a close community that is in interested in all aspects of decision-making in engineering design. The presenter has been funded by the National Science Foundation for the last two decades to research decision-making methods in engineering design. This workshop will continue this effort and will distil many of the lessons learned.

Note: Registration for this workshop is being handled separately from the main conference registration. If you are interested in attending this workshop, select it during your conference registration process. However, you MUST also complete the survey.

Presenter Biographies:

Ali E. Abbas is Professor of Industrial and Systems Engineering and Professor of Public Policy at the University of Southern California, where he also serves as the Director of the USC Neely Center for Ethical Leadership and Decision Making, and previously directed the USC Center for Risk and Economic Analysis of Terrorism Events (CREATE). The recipient of multiple awards from the National Science Foundation for his work, Dr. Abbas' research focuses on decision analysis, risk analysis, multiattribute utility theory, and data-based decision-making. He is author of numerous books including "Foundations of Multiattribute Utility" by Cambridge University Press and is Co-author of "Foundations of Decision Analysis" with Ronald A. Howard at Stanford University. He is also editor of numerous books including "Improving Homeland Security Decisions," and the forthcoming book "Next Generation Ethics and Decision Making" by Cambridge University Press.

Dr. Abbas has organized numerous workshops on Decision Making in Engineering Design, funded by the National Science Foundation, and has recently produced an NSF funded video series on this topic.

Dr. Abbas also has extensive media coverage, and is associate editor and editor for a wide range of journals including *Operations Research, Decision Analysis, IISE Transactions, Entropy,* and *Decision*. He is also guest editor of the special issue of *Operations Research* honoring Nobel Laureate Kenneth Arrow.

Expected Background of Participants:

There are no required or expected areas of experience or knowledge or expertise. Participants will likely be a diverse group of individuals at all points in their careers, from many different specialties.

Expected Audience

This workshop is aimed at attracting faculty, postdocs, Ph.D. students, M.S. students, administrators as well as engineers from industry.

Need for the Workshop or Tutorial

Dr. Ali Abbas has been funded by the National Science Foundation for numerous grants on decision-making in engineering design. This included decision-making in high-speed machining, and decision-making in large systems. He has also organized workshops at NSF, USC, DHS, and NASA Langley on this topic. During the tenure of this effort, Dr. Abbas has observed some widely spread misconceptions and widely used flawed methods of decision-making in engineering design. This workshop continues and distills the efforts over the last two decades to implement normative decision-making in engineering design and large-scale systems.

Impact:

This workshop will continue the efforts of the presenter on numerous NSF-funded workshops on decision-making in engineering design and will distill many of the lessons learned in this effort.

Course Outline

1. Foundations of Preference, Value, and Utility
2. Foundations of Expected Utility
3. Building Preference, Value, and Utility Functions in Engineering Design
4. Group decision-making: What did Arrow really say?
5. The decision analysis hierarchy – From phenomenon to value
6. Some flawed methods of decision making and their implications
7. Making trade-offs in engineering design.
8. The value of information and the value of creating options in engineering design.

Tutorial 7 — Lie Group Modeling of Robot Kinematics and Dynamics – A Hands-on Introduction

August 18, 2019
9:00AM–4PM
~~Palos Verdes A~~, 4th Floor
Monterey

Organizers

Andreas Mueller
Johannes Kepler University Linz
a.mueller@jku.at

Shivesh Kumar
DFKI Robotics Innovation Center
shivesh.kumar@dfki.de

Abstract:

High-fidelity dynamic models are indispensable for the design and control of dexterous robots and robotic manipulators such as parallel manipulators and humanoids. This tutorial gives a concise introduction to the geometric modeling of rigid body robots with arbitrary topology. Here “geometric” refers to the use of screws and Lie groups, which has led to a consistent and user-friendly modeling framework over the last three decades. The simplicity of such formulations is discussed, and it is shown how this leads to geometric modeling concepts that allow for a simple and intuitive modeling in terms of readily available data (instead of Denavit-Hartenberg, for instance) without compromising computational efficiency. The kinematics and dynamics modeling is discussed for serial and parallel, as well as for humanoid robots. Emphasize is given on the practical handling of equations and the computer implementation.

The aim of this tutorial is to introduce modern modeling approach to a wider audience. The tutorial is interactive and accompanied with computer exercises. Attendees are requested to bring their own computer with installed Mathematics or Maple.

Presenter Biographies:

Andreas Mueller is full professor and head of the Institute of Robotic at the Johannes Kepler University Linz, Austria. Prior appointments include positions as researcher University Duisburg-Essen, Germany and at the Institute of Mechatronics, Chemnitz, Germany (also deputy CEO) and as associate professor at the Michigan University – Jiao Tong University Joint Institute in Shanghai. His research interests cover the holistic modeling and model-based control of mechatronic and robotic systems, kinematics and singularities, mobile platforms, redundant serial and parallel kinematics manipulators, flexible lightweight robots, human machine interaction, and safety.

Shivesh Kumar is a researcher in the Robot Control team at the DFKI Robotics Innovation Center, Bremen. He obtained his Master’s degree in Control Engineering, Robotics, and Applied Informatics with specialization in Advanced Robotics from Ecole Centrale de Nantes, France in 2015. He was also an Erasmus Mundus HERITAGE scholar there. Priorly, he holds a Bachelor in Technology degree in Mechanical Engineering from National Institute of Technology Karnataka, India in 2013. His research interests spans kinematics, dynamics and control of serial, parallel and hybrid robots with applications in the fields of exoskeletons, humanoids, rehabilitation, and industrial automation.

Expected Background of Participants:

Basic knowledge of linear algebra, kinematics, and dynamic principles is required.

Expected Audience

The tutorial is intended for graduate students, faculty, practicing engineers, but is also suitable for final year undergraduates. Basic knowledge of linear algebra, kinematics, and dynamic principles is required.

Need for the Workshop or Tutorial

Screw theory is one of the pillars for modeling the kinematics of spatial mechanisms and provides the most important tools for their analysis and synthesis. It has found its way into the relevant curricula, and it is fair to say

that an average graduate will have at least an idea of its basic concepts. This is not the case as soon as the kinematic modeling of robots is concerned, where still classical modeling conventions (e.g., Denavit-Hartenberg) are used. Moreover, screw theory is almost non-existent in the majority of courses on dynamics modeling of robots, despite the fact that research in the last three decades has led to a consistent modeling framework. The mathematical foundation is the theory of the Lie group of rigid body motions. This tutorial offers a hands-on introduction for anyone interested in the topic.

Impact:

This tutorial will contribute to raise awareness of modern approaches to robot modeling and demonstrate their advantages and usability.

Course Outline

The course is split into four subsequent (90 minutes) blocks.

9:00AM-10:30AM
1.1 Introduction, types of robots, topology, main tasks and uses of dynamic models
1.2 Rigid body motions, kinematics of serial robots using the product of exponentials
1.3 Twist, geometric Jacobian
1.4 Computer exercise (Maple/Matlab)

10:30AM-12:00PM
2.1. Acceleration, derivatives of geometric Jacobian
2.2. Dynamics of serial robots
2.3 Computer exercise

1:00PM–2:30PM
3.1 Kinematics of fully parallel manipulators
3.2 Dynamics of fully parallel manipulators
3.3 Computer exercise

2:30PM–4:00PM
4.1 Introduction to series-parallel hybrid robots, challenges in their kinematic and dynamic modeling
4.2 Geometric loop closure constraints: implicit and explicit form, Equations of Motion for systems with closed loops
4.3 Modular and analytical methods for kinematics and dynamics
4.4 HyRoDyn software framework: results and applications