CIE-01 AMS: ADVANCED MODELING AND SIMULATION (AMS GENERAL)

ORGANIZERS:
Seung-Kyum Choi, Georgia Tech, schoi@me.gatech.edu
Piyush Pandita, GE Research, piyush.pandita@ge.com
Ahn Tran, Sandia National Laboratories, anhtran@sandia.gov
James Yang, Texas Tech Univ., james.yang@ttu.edu
Ashish M. Chaudhari, MIT, amchaudhari@mit.edu

DESCRIPTION: The Advanced Modeling and Simulation Symposium provides a venue for researchers to present the original research topics of modeling and simulation, such as:

- Theoretical Advances in Modeling & Simulation in Engineering
- Advances in Finite Element Methodology
- Novel Numerical Techniques
- Advances in Discretization
- Industrial Applications of Modeling & Simulation

CIE-02 AMS: INVERSE PROBLEMS IN SCIENCE AND ENGINEERING

ORGANIZERS:
John Michopoulos, Naval Research Laboratory.john.michopoulos@nrl.navy.mil
Brian Dennis. University of Texas Arlington, dennisb@uta.edu
Athanasios Iliopoulos, U.S. Naval Research Laboratory, athanasios.iliopoulos@nrl.navy.mil

DESCRIPTION

Recent advances in laboratory and industry automation methodologies and practices along with the astonishing progress of computational technologies have enabled a significant growth of data-driven inverse methods for system characterization and design. When it is possible to determine governing equation(s), shape(s) and size(s) of the domain(s), boundary and initial conditions, material properties of the media contained in the field, and internal sources and external forces or inputs, then the analysis determining the unknown field is considered mathematically well-posed and solvable. If any of these elements is unknown or unavailable, then the field problem becomes incompletely defined (ill-posed) and is of an indirect (or inverse) type. The inverse problems can therefore be classified as the determination of unknown shapes, boundary/initial values, sources and forces, material properties, or governing equation(s). If sufficient amount and type of additional information is provided, the inverse problems can become sufficiently specified so that with the use of appropriate algorithms, they can be solved. The algorithmic methods for the solution of inverse problems could be grouped into two basic approaches: pure inverse methods and optimization-based methods. That is, in some methods, sophisticated regularization formulations are used. In other methods, different optimization algorithms are used as tools to solve de-facto inverse problems.

In the present symposium papers are invited on Inverse Problems and their applications from leading international and interdisciplinary research communities. Topics include: 1) Shape design including Topology Optimization 2) Material properties and constitutive response determination 3) Boundary values/initial value identification 4) Force /source determination 5) Governing equation inference. Quality papers will be referred to the ASME Journal of Computing and Information Science in Engineering.

CIE-03 AMS: COMPUTATIONAL MULTIPHYSICS APPLICATIONS

ORGANIZERS:
John Michopoulos, US Naval Research Laboratory, john.michopoulos@nrl.navy.mil
Valeria Krzhizhanovskaya, University of Amsterdam, V.Krzhizhanovskaya@uva.nl

DESCRIPTION

Computational modeling and simulation of multiphysics systems poses grand challenges, to horizontal science and technology disciplines such as engineering, material science, and application sectors such as aerospace, marine and automotive industries Most of the real-life systems involve interactions of multiple physical phenomena. In addition, the time and length scales of the individual processes involved often differ by orders of magnitude. Numerical simulation of these multiphysics problems that involve multiple fields, scales and domains requires development of sophisticated models and methods for their integration, as well as efficient numerical algorithms and advanced computational techniques.

CIE-04 AMS: UNCERTAINTY QUANTIFICATION IN SIMULATION AND MODEL VERIFICATION & VALIDATION

ORGANIZERS:

Yan Wang, Georgia Institute of Technology, yan.wang@me.gatech.edu
Zhimin Xi, Rutgers, State University of New Jersey, zhimin.xi@rutgers.edu
Chao Hu, Iowa State University, chaohu@iastate.edu
Anh Tran, Sandia National Laboratories, anhtran@sandia.gov

DESCRIPTION

The objective of this Symposium is to provide a forum for researchers and industry practitioners who are interested in various aspects of uncertainty quantification in modeling and simulation to improve the reliability and robustness of model prediction. An indicative list of topics is:

- New representations and analysis approaches to quantify stochasticity (random errors) and bias (systematic errors) involved in materials characterization, experimental measurement, model construction, and numerical simulation
- Representations and analysis methods for input uncertainties associated with model forms, parameters, boundary conditions and numerical errors in simulation models
- Algorithms to quantify uncertainty for large-scale simulations and high performance computing as well as algorithm co-design
- Uncertainty propagation in multiscale models
- Probabilistic and non-probabilistic inference to analyze simulation robustness
- Sensitivity analysis of deterministic and stochastic simulation models and optimization under uncertainty
- Bayesian inference and calibration for physics-based simulations
- Monte Carlo approaches, including multi-level and multi-fidelity Monte Carlo methods and applications
- Code verification and simulation validation
- Model accreditation and software standardization
- Application and practice of reliable modeling and simulation (in mechanics, dynamics, materials, as well as aerospace, automotive, building, energy, environment, etc.)

CIE-05 AMS: SIMULATION IN ADVANCED MANUFACTURING

ORGANIZERS:

Gaurav Ameta, *Siemens,* gaurav.ameta@siemens.com
Bjorn Johansson, *Chalmers University of Technology,* bjorn.johansson@chalmers.se

DESCRIPTION

The objective of this Symposium is to provide a forum for researchers and industry practitioners who are interested in various aspects of advanced modeling and simulation to promote smart manufacturing.
An indicative list of topics is:

- Science-based physical modeling of manufacturing processes/systems
- Advanced measurement sciences and technologies for simulation, and analysis that support energy efficient manufacturing
- New engineering approaches for advanced simulation
- IT infrastructure and framework supporting advanced simulation
- Data modeling, integration and interoperability among modeling and simulation tools
- Information ecosystem encompassing gate-to-gate /cradle-to-cradle approaches, advanced data collection and integrated simulation methods
- Uncertainty and completeness approaches, reverse logistics and supply chains modeling
- Industry implementations and demonstrations that are founded on LCA and energy efficient simulations

CIE-06 AMS: MATERIAL CHARACTERIZATION METHODS AND APPLICATIONS

ORGANIZERS:

John Michopoulos, US Naval Research Laboratory, john.michopoulos@nrl.navy.mil
Athanasios Iliopoulos, US Naval Research Laboratory, athanasios.iliopoulos@nrl.navy.mil

DESCRIPTION

Material characterization is an important modeling process as its ability to capture material constitutive behavior physics has a huge impact on the correctness of computational simulation. While the manual physics-based modeling and curve fitting in conjunction with conventional uniaxial testing remains the most common approach, semi-automatic or fully automatic methodologies as well as the development of completely novel techniques that do not rely on the conventional physics-based modeling and uniaxial

testing methodology have appeared recently. This symposium aims at inviting researchers engaged in a wide range of material characterization issues including the development of methods and their applications and advancing material characterization for high-performance simulation.

CIE-07 CAPPD: Computer-Aided Product and Process Development (CAPPD General)

ORGANIZERS:

Chiradeep San, Florida Institute of Technology (csen@fit.edu)
Caterina Rizzi, University of Bergamo, caterina.rizzi@unibg.it,
Gaurav Ameta, *Dakota Consulting Inc*., gameta@wsu.edu,
Tsz-Ho Kwok, Concordia University, tszho.kwok@concordia.ca
Ehsan Esfahani, University at Buffalo (ehsanesf@buffalo.edu)

DESCRIPTION:

This Symposium is focused on the fundamental research and development of computational tools related to product and process realization. This includes research activities on all aspects of product and process development: design, analysis, optimization, process planning, inspection and manufacturing. Relevant work should place a special emphasis on the computational methodologies underlying research in these areas.

The Symposium is soliciting high quality research papers related to Computer-Aided Product and Process Development. They include but are not limited to the following topics:

- Computer-Aided Tools for Product and Process Design, Modeling, Validation and Verification
- CAD/CAM/CAPP/CAE/CIM Techniques
- Feature-Based Design and Feature Recognition
- Collaborative and Concurrent Engineering Techniques
- Geometric Modeling and Optimization for Product and Process Realization
- Computational and Knowledge-Based Reasoning and Representations in Product and Process Development
- Computer-Aided Tolerance Modeling and Analysis

CIE-08 CAPPD: Human-In-the Loop Product Design and Automation

ORGANIZERS:

Ehsan T Esfahani, University at Buffalo (ehsanesf@buffalo.edu)
Dr. Tsz Ho Kwok, Concordia University, (tszho.kwok@concordia.ca)

DESCRIPTION:

The goal of this symposium is to highlight the fundamental research, successful case studies and developed tools for modeling the human interaction and perception in the product design or automation. This includes research activities aiming at consideration of human variability and individual difference in product design, process development, inspection, workspace configuration and interaction with automation. Moreover, this symposium will cover the new advances in interactive interfaces for design system, human factor in design and learning from human demonstration/interaction. The topics of interest include (but not limited) to the followings:

- Design for human variability
- Digital Human Modeling for product life-cycle management
- Human Factor in Design
- Interactive user interfaces for computer aided design and engineering
- Modeling human perception in design
- Human in the loop machine learning
- Human-automation interaction
- Human-robot/machine interaction
- Human-in the loop for informed inspection systems

CIE-09 CAPPD: Digital Human Modelling for Design and Manufacturing

ORGANIZERS:

Giorgio Colombo (Politecnico di Milano), giorgio.colombo@polimi.it
Daniele Regazzoni (Univesity of Bergamo), daniele.regazzoni@unibg.it

DESCRIPTION:

Digital human modeling is attracting more and more attention both from industrial, healthcare and academia world. Depending on the target application, methods and models of different levels of complexity are required. Product ergonomics analyses need biomechanical models able to replicate human movements; while some biomedical applications require a detailed description of the anatomical district under investigation, including internal parts, such as muscles, bones or even blood vessels. At present, many research activities on human modeling and simulation are under development to fulfill the requirements coming from different industrial sectors that can vary from automotive and aerospace to defense, architecture, clothing, bioengineering and healthcare. The aim of this symposium is to provide an overview of current research activities on human modeling methods and applications for product/system design and manufacturing. Topics can include, but are not limited, to the following:

- Modeling Fundamentals and Methods
- Motion Prediction and Motion Capture
- Emotional behavior
- Anthropometric Body Modeling
- Posture and motion analysis
- Human models and Virtual reality
- Virtual Physiological Human
- Computer Aided Ergonomics Analysis
- Ergonomics and safety
- Applications in Industry and Healthcare

CIE-10 CAPPD: Product and Process Design Automation for Industry 4.0

ORGANIZERS:

Marco Rossoni, Politecnico di Milano, marco.rossoni@polimi.it
Lorenzo Failla, Baker Hughes, lorenzo.failla@bakerhughes.com
Anand Balu Nellippallil (anellippallil@fit.edu)

DESCRIPTION:

The digital factory paradigm is transforming design and manufacturing together with the workforce and the work environment. Technologies are no longer a mere support for product development processes, but are integrated into components, machines, management systems, and environments that become more and more complex. Moreover, products, technologies, and processes must be designed, developed, and implemented to be able to seamlessly interact with the digital environment that features the current manufacturing landscape. In such a context, the tight integration between digital and physical assets plays a crucial role in being able to gather and manage huge amounts of data coming from the sensors, elaborate them to extract meaningful patterns and make efficient use within the computer-aided product development process. Besides, the automation of the design and process planning tasks represents an essential feature for a system that wants to operate successfully with digital data and virtual processes.

In such a context, the Symposium is a venue for research papers promoting the discussion around the wide spectrum of applications, theoretical issues, methods, and tools featuring the Product and Process Design Automation for Industry 4.0. The interest includes but are not limited to the following topics:

- Process Planning and Design Automation for Industry 4.0
- Data-driven and Simulation-driven Design and Manufacturing
- Semantic Knowledge Integration and Ontologies in Design and Manufacturing
- Artificial Intelligence and Big Data in the context of Industry 4.0 Product and Process Design.
- Advances in Product Life Cycle Management Tools: Life-Cycle Assessment and integration of circular economy.

CIE-11 CAPPD: Computational Fabrication for Product Design and Development

ORGANIZERS:

Jida Huang, University of Illinois at Chicago, jida@uic.edu
Yayue Pan, University of Illinois at Chicago, yayuepan@uic.edu
Jun Wang, University of Maryland, jwang38@umd.edu
Yunbo Zhang, Rochester Institute of Technology, ywzeie@rit.edu

DESCRIPTION:

With the advancement of emerging process techniques in additive manufacturing (AM), 3D printing is becoming ubiquitous. Fabricating complex, functional and multi-material products with stunning optical and

mechanical properties becomes possible, e.g., cellular structures open up transformative opportunities to produce light-weight and high-performing functional products. Despite the tremendous expansion of AM processes, the design freedom increment brings the computational challenge for product design and fabrication. Designing a product with functional objectives requires coherent computational specification to fabrication methods, which allow designing or computing an object's shape and material composition from a functional perspective. Leveraging the potential of AM requires efficient computational methods for design and fabrication. This session's objective is calling for papers addressing a wide range of computational problems related to design and fabrication in AM. The research topics include but not limited to:

- Generative design and Inverse design of product in AM
- Machine learning and data-driven approaches in structural analysis
- Computational geometry for products design and pre-fabrication with AM
- Fabrication-aware product personalization and customization
- Multi-material functional product design and fabrication
- AM process modeling, analysis, simulation, optimization, and planning

CIE-12 SEIKEM: SYSTEMS ENGINEERING INFORMATION KNOWLEDGE MANAGEMENT (SEIKM GENERAL)

ORGANIZERS:

Yan Lu, NIST, yan.lu@nist.gov
Zhuo Yang (UMass Amherst), zhuoyang@umass.edu
Dazgong Wu (UCF), dazhong.wu@ucf.edu
Douglas Van Bossuyt (NPS), douglas.vanbossuyt@nps.edu

DESCRIPTION

SEIKM invites papers focused on systems engineering and knowledge & information management as they apply to design, manufacturing, and service systems. Areas of interest include system prognostics and health management, design informatics and intelligent information processing, product lifecycle management, project and lifecycle systems engineering, ontology engineering, information discovery, agent-based systems, knowledge and function representation, system engineering, manufacturing IT system architecture and case study, complex systems design and integration, model-based design, and so on. This is the symposium that will host all papers that cannot be classified under any of the rest of the SEIKM topic areas.

CIE-13 SEIKEM: SEIKM: DESIGN INFORMATICS

ORGANIZERS:

Ying Liu (Cardiff University), liuy81@cardiff.ac.uk
Pai Zheng (The Hong Kong Polytechnic University), pai.zheng@polyu.edu.hk
Yuqian Lu (University of Auckland), yuqian.lu@auckland.ac.nz
Xin Guo (Sichuan University), guoxin@scu.edu.cn
Kuo-Yi Lin (Tongji University),19603@tongji.edu.cn

DESCRIPTION:

Design Informatics (DI) studies the representation, perception, processing, computation, communication, storage, retrieval, generation and reuse of information and knowledge in the general context of design. DI has emerged as a multidisciplinary research arena that links up various areas such as information and communication technology, cognitive science and social science, computer science and artificial intelligence, decision and information theory, and design theory. It has been witnessed a pressing demand from the design professionals who are eager to enhance their capability in design information processing and management by harnessing some latest techniques, notably data/text/multimedia mining, semantic technology and ontology engineering, computational intelligence, service oriented architecture, and cloud-based computing. One of the main objectives of DI research is to effectively manage design knowledge in a global context. Hence, this session calls for innovative, state-of-the-art research, technology development and applications of DI. An indicative list of topics is:

- Data/Text/Web/Multimedia mining and analytics in design;
- Information retrieval and search engine dedicated to design information, e.g., CAD elements;
- Enterprise knowledge management portal of Semantic web, Web 2.0 and their application in design;

- Social networking in design;
- Knowledge based/agent based/hybrid intelligent systems;
- Intelligent data acquisition and preprocessing in design;
- Ontology engineering and ontology-based systems integration in design;
- AI based decision support in design knowledge management;
- Digital twins for design innovation;
- Data and knowledge-driven co-creation and living labs;
- Machine learning for cognitive computing in design innovation;
- Data-driven user experience modelling and management;
- Knowledge-based inclusive/universal design for product and social service provision.

CIE-14 SEIKEM: Smart Manufacturing Informatics

ORGANIZERS:

Ying Liu (Cardiff University), liuy81@cardiff.ac.uk
Hyunwoong Ko (ASU), Hyunwoong.Ko@asu.edu

DESCRIPTION:

Smart manufacturing combines information, machine intelligence, and human know-how to enhance the rate and quality, and decrease the cost of launching products into the market. Informatics, that involves the practice of acquiring, storing, processing, and retrieving useful information and knowledge from raw data, domain expertise, and system models, is central to the success of smart manufacturing. This session solicits original research contributions from academia, industry, and government laboratories on both the theoretical foundations and innovative applications of informatics in smart manufacturing. Specific areas of interest include:

- Data integration and federation from disparate and heterogeneous data-capture systems such as machine sensors, operator worksheets, supplier databases, and inventory lists
- Fusion of data, part or assembly designs and manufacturing process models, and human expert or heuristic rules
- Information or knowledge extraction from fused data, models, and rules using descriptive, predictive, or prescriptive analysis
- Information systems integration for enterprise-wide manufacturing applications.

CIE-15 SEIKEM: SYSTEMS ENGINEERING AND COMPLEX SYSTEMS

ORGANIZERS:

Bryan O'Halloran (Naval Postgraduate School), bmohallo@nps.edu
Douglas Van Bossuyt (NPS), douglas.vanbossuyt@nps.edu

DESCRIPTION:

The Systems Engineering track is focused on the integration of systems engineering within engineering organizations and across technical disciplines. This track seeks to discuss tools and methodologies related to enabling the interchange of knowledge, representations and information between toolsets used in systems engineering and other technical engineering areas while fostering an effective interchange in the area of integrated systems engineering between industry, academic and government participants on an international basis. This track aims to provide a context where theoretical approaches, concept demonstrations and effective applications of integrated systems engineering can be published and presented. Systems engineering covers a wide range of complexity levels from very simple systems to highly complex globe-spanning systems. Unique challenges exist at each level of complexity and are of interest to this track.

An indicative list of topics is:

- Integrated systems engineering within engineering organizations
- Model-Based System Design
- Systems Engineering Toolsets and Integration
- Information Systems Security
- Systems of Systems
- Infrastructure Systems Engineering
- Space Systems Architectures
- Case Studies in Systems Engineering

- Analysis tools, methods and modern technologies for complex system design
- Classification and characterization of complex systems
- Systems Engineering education
- Approaches for security and control of cyber physical systems and Internet-of-things (IoT)
- Verification and Validation of systems across all levels of complexity
- Engineering and design research in cyber-physical systems, sociotechnical systems, and smart and autonomous systems.
- Approaches for managing complexity, interdisciplinary interactions, and distributed systems.
- System Interfaces
- Integration of Machine Learning and Artificial Intelligence into the System Design Process

CIE-16 SEIKM: KNOWLEDGE CAPTURE, REUSE, AND MANAGEMENT

ORGANIZERS:

Farhad Ameri (Texas State University), ameri@txstate.edu
Chris Hoyle (Oregon State University) chris.hoyle@oregonstate.edu

DESCRIPTION:

The Knowledge Capture, Reuse, and Management track is aimed to discuss the exploration of research issues associated with transforming engineering design related information into a computable medium. Computable mediums can take several different forms with each form presenting unique challenges for accurately describing, using, and managing the knowledge set. An indicative list of topics is:

- Ontologies for knowledge-capture, reuse, and management
- Visualization, curation, and cognitive considerations of knowledge capture and the use of ontologies
- Semantic Web applications
- Knowledge discovery from social media content
- Logics for knowledge-capture, reuse, and management
- Case studies in design knowledge management

CIE 17 - SEIKEM SPECIAL SESSION: MISSION ENGINEERING

ORGANIZER

Douglas Van Bossuyt (NPS), douglas.vanbossuyt@nps.edu

DESCRIPTION

The Mission Engineering track is focused on the planning, analyzing, organizing, and integration of current and emerging systems and system capabilities to achieve specific mission objectives and outcomes both from a system and a system of systems perspective. This track seeks to discuss tools, methodologies, strategies, case studies, and practitioner insights on mission engineering from a variety of perspectives including but not limited to aerospace, infrastructure, defense, automotive, manufacturing, and supply chain. This track aims to provide a neutral space where industry practitioners, government, and academia from a wide range of fields can come together to discuss current trends in mission engineering in their own respective fields to help foster a bridge between disparate views of what mission engineering is useful for and how mission engineering is conducted. An indicative list of topics is:

- Mission Engineering methodological processes
- Mission Engineering analysis techniques
- Model-Based Systems Engineering practices to support Mission Engineering
- Case studies in Mission Engineering
- Mission Engineering education
- Artificial Intelligence for Mission Engineering
- Risk Analysis and Mission Engineering
- Mission Engineering Decision Support tools
- System of Systems for Mission Engineering
- Digital Twin integration with Mission Engineering
- Mission Engineering tool chains
- Mission Capability assessment
- Mission Engineering Verification and Validation
- Mission Engineering lifecycle

CIE 18 - SEIKM SPECIAL SESSION: SMART PRODUCT-SERVICE SYSTEM

ORGANIZER

Pai Zheng (The Hong Kong Polytechnic University), pai.zheng@polyu.edu.hk
Zuoxu Wang (Beihang University) zuoxu.wang@gmail.com
Xinyu Li (Donghua University) lixinyu@dhu.edu.cn
Tao Peng (Zhejiang University), tao_peng@zju.edu.cn
Yu Zheng (Shanghai Jiaotong University), yuzheng@sjtu.edu.cn
Wenyan Song (Beihang University), songwenyan@buaa.edu.cn
Xin Guo (Sichuan University), guoxin@scu.edu.cn
Ying Liu (Cardiff University), liuy81@cardiff.ac.uk

DESCRIPTION

With the rapid development of digital technologies, Smart Product-Service System (Smart PSS), as an emerging type of PSS, is defined as an IT-driven value co-creation business strategy, by leveraging smart, connected products and its generated services into a single solution to meet individual customer needs. In this context, unlike conventional product or service design process starts from the very beginning of lifecycle, Smart PSS development can be regarded as a closed-loop value generation process by taking both forward design and inverse design process into an overall consideration. Meanwhile, through high-fidelity model and real-time data from sensors, the digital twins of component, module and product levels can be readily established to support product-service family design more cost-effectively. Moreover, enabled by the advanced ICT, users become actively engaged in the value co-creation process and their experience, i.e. user experience, drives the design innovation. Last but not least, AI plays a critical role for smart design decision-makings based on advanced machine intelligence (e.g. crowd sensing) or the human intelligence (e.g. crowdsourcing), and novel approaches integrating both aspects should be explored and leveraged with context-awareness. Given those facts, this special session aims to explore the state-of-the-art enabling technologies to support engineering product-service design/development in today's smart, connected environment. Papers are invited in, but are not limited to, the following topics:

- IT-enabled value co-creation process
- Digital twin-enhanced product design and process innovation
- Design for X in the smart, connected environment
- Crowd sensing for smart product-service innovation
- Human-centric design in smart, connected environment
- AI-enabled product-service family design and optimization
- User experience in the context of smart product-service systems
- Knowledge acquisition, representation and reasoning in product-service design
- Implementation and case studies of smart product-service systems

CIE-19 VES: VIRTUAL ENVIRONMENTS AND DESIGN VISUALIZATION (VES GENERAL)

ORGANIZERS

Vinayak Krishnamurthy (vinayak@tamu.edu)
Marina Carulli (marina.carulli@polimi.it)
Andrea Vitali (andrea.vitali1@unibg.it)

DESCRIPTION

The range of functions in CAD systems for design/mechanical engineering and related domains increases constantly. This complicates the product development process due to an escalating number of components, the interactions among these components as well as by a growing number of involved team members.
Virtual reality applications offer an opportunity to cope with these challenges. Virtual environments are computer-generated immersive 3D worlds that facilitate to experience the design of virtual products. Systems for virtual environments encompass all hardware (system architectures, projection systems) and software (rendering methods, data management), which is required to deploy these types of virtual environments. Those systems also encompass interaction devices, such as multi-touch interfaces, mobile interfaces, haptics-based interaction techniques and interfaces, 3D audio interfaces, and multisensory user

interfaces. The symposium of Virtual Environments and Systems (VES) is a platform to introduce and discuss the latest advances of virtual environments and systems for design and mechanical engineering and related domains.
Specific areas of interest include (but not limited):
- High Resolution and Computer Graphics Techniques for Virtual Environment Systems
- Virtual Human for Virtual Environments in Product Design Processes
- Tracking and Sensing: Emerging Technologies and New Challenges
- Softwarization and Virtual Environments
- Data Management: Big Data and Deep Learning in Virtual Environments for Design Engineering
- Industry Use Cases
- Tangible User Interfaces and Embodied Interactions
- Multisensory Interactive Technologies
- Kinesthetic and Tactile (Haptics) Feedback

OBJECTIVES
Authors and presenters are invited to participate in this event to expand international cooperation, understanding, and promotion of efforts and disciplines in the area of Virtual Environments and Systems (VES General). Dissemination of knowledge by presenting research results, new developments, and novel concepts in Virtual Environments and Systems (VES General) will serve as the foundation upon which the conference program of this area will be developed.
A variety of topics/sessions are available for presentations as it allows flexibility to the authors. All sessions are quality driven.

CIE-20 VES: TECHNOLOGIES FOR VR, AR, AND MR (METHODS, PROCESSES, AND APPLICATIONS)
ORGANIZERS:
Marina Carulli (marina.carulli@polimi.it)
Andrea Vitali (andrea.vitali1@unibg.it)
Christian Lopez Bencosme (lopezbec@lafayette.edu)
DESCRIPTION
A trend from high-end infrastructure and specialized software towards advancement in low-cost Virtual Reality, Augmented Reality, and Mixed Reality devices for virtual products, systems, and services development is undeniable. The growing number of low-cost devices, as well as the established systems, and the expansion of new capabilities progressively change the functionality of virtual products. Virtual products become more and more realistic and help to cope with the challenges of product design and development.
The involvement of the human in the product design process remains vital in interaction, decision-making, cognition, and usability studies. The application of existing (i.e. early-stage development) and the development of new modeling approaches in the field of Systems Engineering (SE) and Model-Based System Engineering (MBSE) and the integration of SE and MBSE tools with the existing simulation tools are also important topics to address for this session.
The symposium addresses the available technology to create virtual products that encompass all hardware systems and software that are required to deploy virtual, augmented, and mixed reality environments. The symposium of Technologies for Virtual Reality, Augmented Reality, and Mixed Reality is a platform to introduce and discuss the latest advances of those technologies and devices for design, mechanical engineering, and related domains.
Specific areas of interest include:
- Methods and Tools for Developing Virtual Environments in Design Engineering
- Tracking and Sensing (Strategies, Hardware, and Software)
- Hardware and Software for Facilitating Product Design Processes
- Virtual Environments for Industrial Design and Engineering: Challenges and New Opportunities
- Novel Interaction techniques in virtual, augmented, and mixed reality
- Novel Applications of virtual, augmented, and mixed reality technologies
- Gamification through Virtual Environments
- Industry Use Cases
- System architecture and interface modeling

- Human-machine intelligence in systems
- Modeling of Human and its behavior

Objectives
Authors and presenters are invited to participate in this event to expand international cooperation, understanding, and promotion of efforts and disciplines in the area of Technologies for Virtual Reality, Augmented Reality, and Mixed Reality. Dissemination of knowledge by presenting research results, new developments, and novel concepts in Technologies for AR, VR, and MR will serve as the foundation upon which the conference program of this area will be developed.
A variety of topics/sessions are available for presentations as it allows flexibility to the authors. All sessions are quality driven.

CIE-21 AMS-CAPPD: DIGITAL TWIN: ADVANCED HUMAN MODELING AND SIMULATION IN ENGINEERING
ORGANIZERS:
James Yang, Texas Tech University, james.yang@ttu.edu
Yujiang Xiang, Oklahoma State University, yujiang.xiang@okstate.edu
Xianlian Alex Zhou, New Jersey Institute of Technology, alexzhou@njit.edu
Tsz Ho Kwok, Concordia University, tszho.kwok@concordia.ca
DESCRIPTION: Most engineered products require human interaction at some point in their lifecycles. It is important to consider human factors related to using designed products in the early stages of design for many reasons. The first reason is to preserve human integrity and safety and to ensure comfort in all tasks. The second reason is to simulate or assess the performance of machines or robotic devices for human-machine/device collaboration/interaction, human performance augmentation, rehabilitation, or injury prevention. Thirdly, while performance may vary from user to user, energy consumption, expected life, sustainable user behavior, and maintenance behavior may also vary and significantly influence global lifecycle cost as well as environmental impacts. Finally, it is useful for human-centric design. Many human simulation models have been developed or are in the making such as skeletal, musculoskeletal, and finite element human models. These models can be interfaced with computer-aided design environments to test the designed products or devices to save time and money. Various methods have been proposed such as computational models, data-driven or optimization-based approaches. Applications of digital human modeling and simulation occur in industry, military, and clinical practice. The aim of this symposium is to provide a venue to present the state-of-the-art research results on human modeling and simulation in engineering. Topics include, but are not limited to, the following:
- 3D human modeling, Whole body biomechanics, Crash models, Injury prediction
- Anthropometric analysis, Advanced measuring methods
- Machine learning/AI in human modeling and analysis
- Modeling of comfort and discomfort, Modeling of human behavior, Simulation of usage compliance
- Motion and posture prediction, Gait or movement analysis, Hand modeling and applications
- Observation, Validation and verification of usage-related tasks
- Whole-body vibration of digital humans, Fatigue modeling, Cloth modeling
- Cognitive modeling, Virtual/mixed/augmented reality and human modeling
- Bio-inspired design/human-centered design
- Engineering ergonomics, Human factors
- Exoskeletons, Exosuits, Human-machine interaction, and Human-robot collaboration

CIE-22 DTM-SEIKM: HUMAN SYSTEM INTEGRATION
ORGANIZERS:
Zhenghui Sha (UT Austin), zsha@austin.utexas.edu
DESCRIPTION
Although the rapid development and implementation of automation and artificial intelligence (AI) in almost every industry in the past decade, the design, operation, and maintenance of many complex systems cannot be realized without human decisions and supervision. For example, even in the best case, automated manufacturing systems are rarely able or advised to replace maintenance personnel directly. Instead, better operational performance might be achieved by using technologies that maximize the ability of personnel to perform their tasks. Similar situations exist in various system contexts ranging from infrastructure systems (e.g., the cybersecurity issues in power systems) to defense systems (e.g., human-

weapon teaming), which epitomize the rise of Intelligence Augmentation (IA). IA is an alternative conceptualization of AI but focuses on its assistive role, emphasizing the fact that it is designed to complement and amplify human intelligence rather than replace it. For instance, in the context of maintenance in manufacturing operations, such as an augmentation can be achieved by improving the design of algorithms that support operation and maintenance teams by directly designing to the skills and limitations of personnel. Given that complex systems engineering will continue to be a predominantly human-based enterprise, advances must incorporate strengths and weaknesses of both human and algorithm to support Human-centered Design (HCD) and enable Human-System Integration (HSI). This paradigm shift toward collaboration between humans and systems must be holistically applied, as mounting technological, logistic, organizational, and cultural challenges stand between the current state of practice and complex systems engineering of the future.
Specific topics of interest include, but are not limited to:

- Human collaboration and competition with artificial agents in teams, crowds, and with individuals
- Uses for AI and other algorithmic enhancement in support of systems operation
- Trustworthy AI systems in systems design, integration, and operation
- Group dynamics that involves artificial teammates
- Decision models for deciding whether, when, and how to access human inputs
- Technical natural-language processing (NLP) for work-order annotation, data structuring, and expert elicitation
- Application of knowledge graphs or ontologies for contextualizing AI in question-answering
- Data-driven anthropometric or behavioral models, for example, to quantify error sources and prevent mistakes and shortcomings of individuals
- Novel visualization tools and user interfaces with quantified improvements over traditional methods
- Sensory feedback designs that minimize confusion, obfuscation, or mistrust of personnel
- Individual differences that impact collaboration with and acceptance of artificial intelligence

CIE-23 AMS-CAPPD-SEIKEM: Design, Simulation and Optimization for additive manufacturing

ORGANIZERS:
Hyunwoong Ko (ASU), Hyunwoong.Ko@asu.edu
Yan Lu, NIST, yan.lu@nist.gov
Zhuo Yang (University of Massachusetts Amhurst), zhuoyang@umass.edu
DESCRIPTION
AM has been a hot topic in CIE for few more years. We received 14+ full paper submissions in 2022 as a special session. It may be time to regularize this topic to be a regular session. AM is an important part of advanced manufacturing. The unique features of AM process allow the freedom of design for complex part geometry that can be impossible for traditional manufacturing. This session covers the fundamental research in AM about: 1) how to design AM part, 2) how to optimize the AM process, 3) how to use simulation, either physics-based or data-driven, to reveal the physics of the process.
Specific topics of interest include, but are not limited to:
- Part design for AM processes and applications
- Design rules and guidelines for AM
- Design optimization for AM
- AM design of experiment
- AM information model
- Physics-based AM simulation using such approaches as FEA and CFD
- AM Data-driven models
- System design and optimization for AM

CIE-24 AMS-CAPPD-SEIKEM: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN DESIGN AND MANUFACTURING
ORGANIZERS:
Yan Lu, NIST, yan.lu@nist.gov
Zhuo Yang (University of Massachusetts Amhurst), zhuoyang@umass.edu
DESCRIPTION
The fast development and recent breakthrough of AI and machine learning techniques has enabled many

new discoveries and new research opportunities in many engineering disciplines, including the SEIKM community. For example, new computational approaches and computational reasoning enable advances in systems engineering design and operations. This session solicits original research on machine learning and AI in the context of systems engineering, and knowledge discovery and management. Specific areas include:

- AI applications on system design, generative designs, and requirements engineering
- Machine learning and AI applications during operation, control, fault identification, slow fault prediction, process adaptation
- Deep neural network and deep reinforcement learning in systems engineering
- Application of adversarial machine learning in complex systems design
- Reasoning and learning for human-in-the-loop systems engineering