CIE 2023 Topics

CIE-01 AMS: Advanced Modeling and Simulation (AMS General)

Organizers
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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
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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:

- Shape design including Topology Optimization
- Material properties and constitutive response determination
- Boundary values/initial value identification
- Force /source determination
- 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
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Description

Computational modeling and simulation of multiphysics systems pose grand challenges, to 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. Computational simulation of these multiphysics problems that involve multiple fields, scales, and domains, requires the development of sophisticated models and methods for their integration, as well as efficient numerical algorithms and advanced computational techniques.

In the present symposium, papers are invited on computational Multiphysics modeling and simulation, along with their applications from leading international and interdisciplinary research communities.

Topics include:

- Coupled field problems
- Multiscale problems
- Multi-domain problems
- combinations of all or some of the above.

CIE-04 AMS: Uncertainty Quantification in Simulation and Model Verification & Validation

Organizers
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Description

This Symposium aims 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 variance (random errors) and bias (systematic errors) involved in model construction, numerical simulation, materials characterization, and experimental measurement
- Representations and analysis methods to quantify model-form and parameter uncertainty as well as input uncertainty and numerical errors in simulation models
- Efficient algorithms to predict uncertainties in large-scale simulations and high-performance computing environments
- Advanced surrogate modeling, multi-fidelity, multi-objective, scalable, high-dimension, for practical problems
- Uncertainty quantification in machine learning models
- Uncertainty propagation in multiscale modeling
- Probabilistic and non-probabilistic inference to analyze simulation robustness
- Sensitivity analysis for deterministic and stochastic models
- Optimization under uncertainty and PDE constraints
- Bayesian inference and calibration of physics-based models
- Monte Carlo approaches, including multi-level and multi-fidelity Monte Carlo methods and applications
- Code verification and simulation validation
- Evaluation methods to assess quality of uncertainty quantification
- Model accreditation and software standardization

- Application and practice of reliable modeling and simulation (in the domains of mechanics, materials, dynamics, control, and robotics, for systems in extreme environments, as well as in the industries of aerospace, automotive, biomedical, energy, etc.).

CIE-05 AMS: Simulation in Advanced Manufacturing

Organizers

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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, such as digital twin of value chains, factories and manufacturing systems
- 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

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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 user-guided physics-based modeling 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 in the areas of solid mechanics, heat and mass transfer, electromagnetics, and their combinations thereof.

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

Organizers

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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

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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

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Description

Digital human modeling is attracting 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. This topic is aimed at including papers about 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
- Posture and motion analysis
- Human models and Extended reality
- Digital Humans in digital manufacturing processes
- Computer Aided Ergonomics Analysis
- Physical and cognitive Ergonomics
- Applications in Industry and Healthcare

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

Organizers:
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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: Data-Driven Product Design and Fabrication

Organizers
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Description

The goal of this symposium is to highlight the fundamental research, developmental studies, and computational tools in data-driven product design and fabrication. With the advancement of digitalized manufacturing techniques, there is an increasing need for data-driven methods

in the automated design and fabrication of complex, functional and user-centric products. In light of the digital twin, designing a product with functional objectives requires coherent computational specification and fabrication methods to achieve optimal configuration (object's shape, architecture, and material composition). Leveraging the potential of data-driven approaches, this symposium is calling for papers addressing a wide range of product design and fabrication problems in a data-driven paradigm. The topics of interest include (but not limited) to the followings:

- Machine learning and data-driven approaches in product and process design
- Generative design and inverse design for product development
- Fabrication-aware design and design for manufacturability
- Personalized product design and fabrication
- Computational geometry for products design and fabrication
- Virtual product design, simulation, and fabrication.

CIE-12 SEIKM: Systems Engineering Information Knowledge Management (SEIKM General)

Organizers

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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 SEIKM: Design Informatics

Organizers

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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
- 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

CIE-14 SEIKM: Systems Engineering and Complex Systems

Organizers

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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
- Mission Engineering

CIE-15 SEIKM: Knowledge Capture, Reuse, and Management

Organizers

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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. The scope of this track extends to transdisciplinary information in engineering design (e.g., bioinspired) which could inspire new approaches to knowledge capture, reuse, and management. 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-16 SEIKM: Smart Manufacturing Informatics

Organizers

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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-17 SEIKM: Advanced Manufacturing for Bioeconomy and Circular Economy

Organizers

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Description

Severe supply chain slowdowns and material shortages in 2021 and 2022 have highlighted the extreme sensitivity of global supply chains to disruptions such as to raw material availability, staffing availability, or even changes in production plans due to market conditions. Modern global supply chains are efficient and productive, but the optimization that enables this has also made the system brittle.

Biomanufacturing and an increased circular manufacturing economy are potential ways to increase the resilience of global supply chains with little negative impact, while at the same time improving sustainability.

Biomanufacturing is a technology that can produce medicines, food, fuels, plastics, and other materials without petrochemicals addressing some of the circular economy objectives. Industry analysis suggests that bioengineering could account for more than a third of global output of manufacturing industries before the end of the decade. But this will require tools, models, and methods to design these products, processes, and production facilities, as well as software to monitor and manage this form of production.
A circular economy reroutes waste (from products at end of life, as well as other sources) back into manufacturing processes, providing a largely untapped local source for input materials. But turning waste into a viable manufacturing input either through traditional or bio-based manufacturing processes will require exchange of detailed information about the materials composition, and in some cases, history. It may also require better understanding of the chemistry of the materials, new ways of processing them, and perhaps even the development of new virgin inputs that are more easily reused.
Harnessing data is seen as one important advance in biomanufacturing and supply chain as evident from the formation of the Big Data Program at the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). For the circular economy, data collection, management, interoperability, and security remain focus points for operationalizing circularity in manufacturing. However, there are challenges in harnessing data that are related to both biomanufacturing and the circular economy including:

- Lack of common standard for collecting and sharing data and also models produced from them.
- Lack of infrastructure for sharing data confidentially and privately.
- Need for better sensors for collecting data faster.
- Need for improvements in control and process-development models
- Need for improvement in equipment integration
- Need for exploration in data ownership and rights

Topics of interest to this session include models and data-driven approaches that address these challenges such as:

- Standards, technologies, or methods for sharing and learning from data and models of manufacturing and supply chain equipment/processes that may address issues in digital twin, digital thread, transfer learning, or data privacy
- Methods for sharing data confidentially and securely
- Advances in data models for modular equipment integration (plug-and-play)
- Models of biomanufacturing processes and products
- Application of dynamic control strategies
- Soft sensors for bioprocesses
- Data and knowledge management in biomanufacturing
- Approaches for modeling aggregate flows at the supply chain level (macro level tracking)
- Approaches for tracking instances of materials through their lifecycle (micro level tracking)
- Mapping of disparate data sources along the manufacturing and supply chain domains.

CIE-18 VES: Designing User Experiences for Virtual Environments

Organizers

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Description

Virtual environments and systems embody a broad range of computer systems. A virtual environment is *any type of environment in the reality-virtuality spectrum is a virtual environment* and a virtual system is a *system that embodies the interplay across humans,*

computing devices, interaction technologies, and feedback mechanisms. Such environments may include pen and multi-touch interfaces, mobile devices, wearable technologies (smartwatches, custom wearable systems for tracking, and interactions), spatial user interfaces (e.g. using Kinect, Leap Motion, and other controllers), virtual reality systems (including desktop VR, mobile VR, and head-mounted displays), augmented/mixed reality systems (head-mounted, tablet-based, and mobile-based), haptics-based interaction techniques and interfaces, 3D audio interfaces, and tangible user interfaces (such as those that use day-to-day physical objects for virtual manipulation). Any research aimed at advancing the state of knowledge to advance virtual environments and systems (as qualified above) is welcome.

The design of user experiences in virtual environments is inherently predicated upon a fundamental understanding of human perception, cognition, behavior, and action. Systematic investigation of new and existing user interactions, spatial technologies (cameras, controllers, haptics devices), visual representations of geometric and contextual information, and user preferences (such as gesture elicitation, micro-gestures) is critical in order to gain insights for virtual environment design. This symposium seeks contributions that aim to enrich user experience in virtual environments through the development and evaluation of (a) new ways to interact with virtual objects, (b) new ways of interaction with other people in virtual spaces, (c) new ways to represent visual as well as non-visual information in virtual environments, and (d) new insights on how users behave and perform in virtual environments. Research efforts on defining, measuring, and understanding user experience in virtual environments are also of interest. Specific topics of interest include (but are not limited to):

- Collaborative and multi-user virtual environments
- Integration of multi-touch and spatial user interfaces
- Mobile interactions and wearable technologies
- Speech-based interactions
- Visualization of geometric data (3D models, point-clouds, etc.)
- Visualization of non-geometric data (simulation results, scene summaries)
- Graphics, geometric modeling, and geometry processing for virtual environments
- Data collection, analysis, and studies of user actions and performance
- Haptics- and gaze-based interactions in VR/AR/MR
- Utilizing physiological sensors (EEG, ECG, etc.) in virtual environments

CIE-19 VES: Virtual Systems for Engineering Applications

Organizers

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Description

User interfaces, interactions, and experiences are now pervasive in design, manufacturing, product inspection, customization, healthcare, education, technical training, and even daily consumer activities such as online purchases. The levels of user immersion possible within the reality-virtuality continuum can have profound effects on how designers design, engineers produce, and consumers use products. This is due to the unique affordances offered by the flexibility and intuitiveness of interaction with virtual objects and environments, the immersive experience and context-aware information visualization, perceptions about spatiality and dimensionality, and multi-modal (visual, auditory, and tangible) feedback. This symposium invites innovative research that incorporates technologies around virtual environments within concrete application contexts relevant to all domains of engineering. Specific topics of interest include (but are not limited to):

- Creativity-support for design and shape modeling
- Reverse engineering

- Human-robot/machine interaction
- Immersive education and training with VR/AR/XR
- Healthcare applications in VE
- Designing VE for accessibility, disability, and wellbeing
- Speech-driven interfaces for design & manufacturing
- Virtual environments for decision making

CIE-20 VES: VES Show-and-Tell

Organizers

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Description

Research in virtual environments and systems often leads to the development of innovative software, hardware, and complete working systems. The *VES Show-and-Tell* event invites academic and industry researchers to submit proposals for live demonstrations of hardware and software systems developed to advance the design of virtual environments. Presenters are expected to showcase the progression and development of all forms of CIE-related software/hardware prototypes, applications, demos, systems, or simulations. We invite researchers from cross-domains (multi-disciplinary) to participate in this event to participate and become part of this CIE community by sharing examples of their work. Submissions are welcome across any application domain and any system that embodies the interplay across humans, computing devices, interaction technologies, and feedback mechanisms is welcome. ***Authors of papers submitted and/or accepted to any of the regular VES sessions are particularly welcome to submit their work to this event. The top two exhibits will be selected and honored at the conference.***

Here are the submission guidelines:

- A 3-page ***proposal*** (in the ASME IDETC format) detailing the following:
  - Aim of system being displayed
  - Potential audience that will be interested in your exhibit.
  - Components of the system (with flowcharts etc., if applicable)
  - High quality images of the system in action.
  - Any specific requirements (power outlets, tables, etc.) for exhibiting the system.
  - If the system is based on a paper submitted to ASME IDETC/CIE, please refer to the paper as well.
- ***Poster*** describing the system, its motivation, and capabilities. 24” x 36” in size
- ***Demonstration at the event***: We strongly encourage participants to demonstrate the actual system at the conference; However, a video of the system in action will be permitted in cases where it is difficult to transport the system components to the conference (e.g., systems involving moderate to large-scaled hardware systems).

CIE-21 AMS/CAPPD Joint Topic: Digital Twin: Advanced Human Modeling and Simulation in Engineering

Organizers:

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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 AMS/SEIKIM Joint Topic: Digital Twin Modeling and Analytics for Advanced Manufacturing

Organizers

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Description

Digital twin is a key technology for digital transformation and intelligent advancement in developing innovative manufacturing processes such as smart additive and semiconductor processes. This symposium focuses on the areas of digital-twin modeling and analytics and associated applications in advanced manufacturing considering processes, designs, materials, and products at multiple scales. Driven by emerging data and models, such as in-situ industrial internet of things (IIoT) sensor and non-destructive evaluation data, machine-learning and AI models, and physics-based simulations, the digital-twin modeling and analytics shows high potential to improve understanding and predictions about critical physical entities and processes and enhance decision-making, control, and product evaluation activities. We cordially invite you to participate in this exciting workshop; topics of interest include but are not limited to:

- Digital Twin for Characterizing Physical Entities and Properties in Advanced Manufacturing at Multiple, Spatial-Temporal Scales
- Data-Driven Machine Learning and AI for Digital Twin in Advanced Manufacturing
- Digital-Twin-Driven In-situ Quality Assurance for Advanced Manufacturing
- Digital-Twin Modeling Driven by Physics-Based Simulation for Advanced Manufacturing
- Digital-Twin-Driven Decision-Support in Design, Process Planning and Control, Part Evaluation, and Scheduling

- Integration of AI, IIoT Sensing, and Simulations for Digital Twin in Advanced Manufacturing
- Digital-Twin-Driven Meta-Factory
- Digital-Twin-Based Supply Chain Management

CIE-23 AMS/SEIKIM Joint Topic: Physics-Informed Machine Learning for Design and Advanced Manufacturing

Organizers
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Anh Tran, Sandia National Laboratories, anhtran@sandia.gov
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Description

Despite great progress in simulating multi-physics and multi-scale problems by solving partial differential equations (PDEs), there have been challenges for applying physics-based models in design and manufacturing. They include (1) incorporation of noisy data into existing simulations, (2) complex mesh generation, (3) high-dimensional problems governed by parameterized PDEs, (4) expensive inverse problems with hidden physics, and (5) necessity of real-world data in model development, validation, and verification.
Scientific machine learning (SciML) including deep learning has been applied successfully in diverse design and manufacturing fields to address the above challenges. Nevertheless, data sparsity is still the main challenge to apply these models to solve complex scientific and engineering problems. The root cause is the ‘‘curse of dimensionality’’ in training these models. Training algorithms need to explore and exploit in a very high dimensional parameter space to search the optimal parameters for complex models. When the dimension increases, the required amount of training data grows exponentially in order to cover the space and ensure the convergence of training. Because data acquisitions in scientific experiments and high-fidelity engineering simulations are very costly, it is difficult to collect enough training data to fully train complex models. In addition, black-box ML models may not obey the fundamental physical laws and often fail to provide accurate predictions beyond the training data.

To tackle these challenges, a new paradigm called physics-informed machine learning is emerging to embed physics into ML models, where physics-based models are applied as constraints to guide the training of ML models (e.g., physics-informed/constrained neural networks, physics-informed Gaussian process, etc.). Also, physical laws can provide additional information (e.g., random data points in the continuous space-time domain or governing relationships) to train ML models more efficiently. Therefore, this hybrid approach can significantly reduce the required amount of training data and make the ML models more interpretable, generalizable, and trustworthy. This symposium focuses on research advances in the areas of physics-informed machine learning and associated applications in processes, materials, and products in design and advanced manufacturing. Physics-informed machine learning can significantly improve the manufacturing efficiency, quality, and cost effectiveness by providing accurate predictions for decision making. We cordially invite you to participate in this exciting workshop; topics of interest include but are not limited to:

- Physics-informed machine learning for multiscale process-structure-property relationships in materials science;
- Physics-informed machine learning for process and equipment monitoring, diagnostics and prognostics, and process control;
- Physics-informed machine learning for process/materials design and optimization with advanced manufacturing applications;
- Physics-informed machine learning for product design and performance enhancement;
- Uncertainty quantification in physics-informed machine learning;
- Physics-informed machine learning for ex-situ, non-destructive evaluation;

- Physics-informed machine learning for topology optimization to enhance product performance and manufacturability;
- Physics-informed machine learning for conceptual design to incorporate functional requirements;
- Physics-informed machine learning for identification and characterization of physical phenomena in advanced manufacturing.

CIE-24 SEIKM-AMS: Artificial Intelligence and Machine Learning in Design and Manufacturing

Organizers

Jiarui Xie, McGill University, jiarui.xie@mail.mcgill.ca
Yaoyao Fiona Zhao, McGill University, yaoyao.zhao@mcgill.ca

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

CIE-25 AMS-CAPPD-SEIKM: Design, Simulation and Optimization for Additive Manufacturing

Organizers

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Fahad Milaat, NIST, fahad.milaat@nist.gov

Description

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–26: Graduate Student Poster Symposium

Organizers

Jun Wang (Lead), University of Maryland, jwang22@scu.edu
Satchit Ramnath, The Ohio State University, ramnath.17@osu.edu

Description

The ASME-CIE Graduate Research Poster session is an opportunity for graduate students in the preliminary phase of their research programs (MS or within 2 years of starting a PhD) to present their current work to the CIE research community. This session provides the students a chance to obtain external feedback on their preliminary research that may not yet be ready for presentation at the conference in archival form.
Scope of the Research Posters
The research poster should be relevant to the areas of interest of one or more CIE Technical committees that are listed below:

- Advanced Modeling and Simulation (AMS)
- Computer-Aided Product and Process Development (CAPPD)
- Systems Engineering, Information and Knowledge Management (SEIKM)
- Virtual Environments and Systems (VES)

Stipends and Eligibility
The ASME CIE division will offer stipends (the amount and number are to be confirmed) to support graduate students attending the 2023 CIE Conference to present their research posters. Poster submissions reflecting relevant and high-quality research will be favored in the awarding process. To be eligible for a stipend, the student must be attending a university or college as a graduate student at the time of the 2023 CIE Conference and must be a student member of ASME. Awardees of the CIE stipends are required to attend the conference and present the poster as a condition of the award.
Submission of Abstract and Application
To contribute to the research poster session and be considered for the stipend award, all interested applicants must submit a CIE poster application package by the deadline (date to be decided).
The application package should be submitted as a single PDF file using the conference webtool submission portal. The application package should include the Application Form, Extended Abstract, and a Reference Letter from research advisor. Please note that late or incomplete submissions will not be considered. More details will be posted on the ASME IDETC-CIE 2023 webpage.

CIE 2023 Special Sessions

CIE-VES: JCISE Spotlight Talks on Extended Reality in Design and Manufacturing

Organizers:
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Yunbo "WILL" Zhang, Rochester Institute of Technology, ywzeie@rit.edu
Vinayak Krishnamurthy, Texas A&M University, vinayak@tamu.edu

Description
Extended Reality (XR) is a collective term containing Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and everything in between. Integrated with emerging technologies such as artificial intelligence (AI), 5G, and industrial internet-of-things (IIoT), XR applications have been successfully deployed in the fields of industry, entertainment, education, and healthcare. This special session will invite papers accepted for the JCISE special issue on extended reality in design and manufacturing. The purpose of the special issue is to solicit articles describing fundamental and applied research on XR techniques, solutions, and challenges in the area of design and manufacturing. This issue covers all aspects of XR technology related to mechanical engineering.

CIE 2023 PANELS

CIE AMS-SEIKM Panel: Digital Twin for Smart Manufacturing

Organizers

Dehao Liu, Binghamton University, dehaoliu@binghamton.edu

Description

Smart manufacturing enables the amalgamation of interconnected machines and tools to improve manufacturing performance by optimizing the energy, material and required labor by leveraging technologies such as internet of things (IOT), artificial intelligence, and advanced robotics. In the age of the Industry 4.0, Digital Twin (DT) technology has drawn significant attention as a disruptive digital technology that has the great potential to transform the landscape of smart manufacturing. As a virtual replica of a real-world physical system or process (i.e., a physical twin), DT provides a means of simulating, predicting, controlling, and optimizing physical manufacturing systems and processes. It is envisioned that DT-based smart manufacturing will significantly improve the production process in terms of quality, efficiency, productivity, and flexibility. The power of DT comes from the underlying digital models, which could be physics-based models, machine learning models, or their combinations. However, it is still a main research challenge to create accurate and computationally efficient digital models for real-time or near real-time process monitoring, prediction, and control. On the one hand, physics-based models have good generalization ability, but they are not computationally efficient for real-time prediction. On the other hand, machine learning models are computationally efficient for real-time prediction, but they have poor generalization ability. One possible solution could be physics-based machine learning models, where prior physical knowledge and training data (sensor data, simulation data, etc.) can be integrated together.
The panel will discuss challenges and technical approaches in the following topics:

- What is DT?
  - Definitions
  - Theories
  - Technical Enablers
  - State of The Art
- Emerging methods for model building, calibration & validation, adaptive learning & updating for DT;
  - DT in Smart Manufacturing
  - Needs of DT for Smart Manufacturing
- Applications
  - Real-time or near real-time process monitoring, prediction, and control;
  - Distributed systems with improved symmetry and security;
  - Product/process design, validation, and continuous improvement;
  - DT interactions with cloud/fog/edge infrastructure for IoT;
  - Uncertainty quantification for DT;
  - Rapid qualification
- Gaps and Challenges
- Future Insights on DT for Smart Manufacturing

CIE CAPPD Panel: TBD

Session chair: TBD
Description: TBD
Objectives: TBD

CIE SEIKM Panel: TBD

Session chair: TBD
Description: TBD

Objectives: TBD

CIE VES Panel: "VES4Access" – Accessibility, Inclusion, and Wellbeing in Virtual Environments

Organizers:
Vinayak Krishnamurthy, Texas A&M University, vinayak@tamu.edu
Yunbo "WILL" Zhang, Rochester Institute of Technology, ywzeie@rit.edu

Description
As immersive technologies become more pervasive in our daily lives, the design of virtual experiences needs thoughtful considerations regarding accessibility, inclusion, and wellbeing of users in these spaces. The ever-increasing human consumption of virtual experiences is bound to have profound effects on both the mind and the body. How should we design such experiences to include individuals with physical, mental, and emotional disabilities? Are there ways to leverage the unique capabilities of virtual worlds to augment users' capabilities and also promote their well-being? What considerations should be given to social aspects of multi-user virtual environments? These questions have far-reaching implications for applications involving virtual space, by making visual technologies accessible to the vision-impaired, innovations in haptics to facilitate therapeutic experiences and remote healthcare, or social dynamics in multi-user immersive experiences.

Objectives
The objective of this panel is to bring together a group of experts in design for accessibility, computer-aided product design, social sciences in engineering, design education, human-computer interaction, and digital technologies for a cross-disciplinary discussion on the past, present, and future of accessibility, inclusion, and wellbeing in virtual environments. The panel discussion will explore: (1) where these two domains (VES and accessibility) meet, (2) how they will give rise to new research and development opportunities, (3) what intellectual challenges lie ahead in designing VES for accessibility, inclusion, and wellbeing, and (4) what steps we should take as researchers to investigate this exciting avenue.

CIE Hackathon Panel: TBD
Session chair: TBD
Description: TBD
Objectives: TBD