CAASE18

The Conference on Advancing Analysis & Simulation in Engineering

June 5 - 7, Cleveland, Ohio

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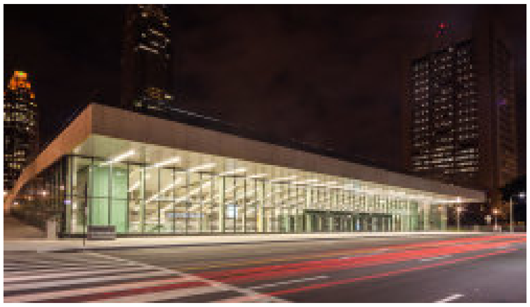
Venue

Huntington Convention Center of Cleveland
300 Lakeside Ave E
Cleveland, Ohio 44113



Conference App

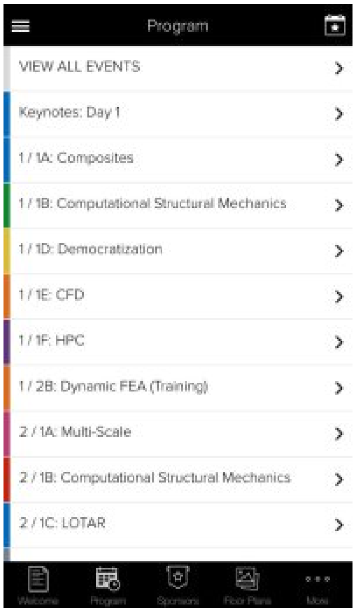
We are excited to announce the availability of the CAASE18 Conference app. Our hope is that this new tool will put the entire event at your fingertips to ensure you get the most of out your participation.

How to Download

1. Visit http://my.yapp.us/CAASE on your device and follow the instructions on the page

2. You'll be asked to install Yapp from the app store (if you don't have it already)

3. Open Yapp and tap "Download an existing Yapp" and your app will appear.



Keynote Presentations

Piero Aversa
Chief Engineer, Global Powertrain NVH and CAE, Ford Motor Company
Providing the Transformational Means to a New Era of Sustainability and Mobility

Dan Robles
Founder / Director, Integrated Engineering Blockchain Consortium
Why Engineers Must Pay Serious Attention to Blockchain Technology

Tuesday
June 5th

Wednesday
June 6th

Caralynn Nowinski Collens, M.D.
Chief Executive Officer, UI LABS
Accelerating Innovation through Collaboration

Jerry Overton
Data Scientist, DXC Technology
AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant

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Patrick Safarian, Ph.D., P.E.
Fatigue & Damage Tolerance, Senior Technical Specialist, FAA
Requirements of Certification by Analysis

Tina Morrison, Ph.D.
Deputy Director, U.S. Food and Drug Administration
Priorities Advancing Regulatory Science and In Silico Medicine at the FDA

Thursday
June 7th

The evening of June 6th....
Rockin' Night Out with Dinner and All Access Passes to the Rock & Roll Hall of Fame

Rock & Roll Night Out

We are excited to announce that attendees of CAASE18 will have an opportunity to visit the world's foremost museum devoted to the celebration and preservation of rock & roll music - the Rock & Roll Hall of Fame. Plan to spend a minimum of 2 hours perusing artifacts of music history and interacting with audio-visual exhibits.

Upon arriving at the Rock & Roll Hall of Fame, participants will be treated to food and beverages (three meal options available, plus two drink tickets).

nafems.org/CAASE18

CAASE18 At-a-Glance

Day 1 (T*uesday, June 5th*)

Room	**1-1:** 11:20am - 1:05pm	**1-2:** 2:20pm - 4:05pm	**1-3:** 4:35pm - 6:20pm
20	*NAFEMS Training: Dynamic FEA*	*NAFEMS Training: Fatigue & Fracture Mechanics in FEA*	*NAFEMS Training: Composite FEA*
21	Multiscale	*Multiscale Modeling of Composite Structures Using Mechanics of Structure Genome*	*Introduction to Probabilistic Analysis and Uncertainty Quantification*
22	Optimization 1	*Topology Optimization: Opportunities and Challenges*	*ASSESS Initiative: Collaborating with NAFEMS to Enable the Simulation Revolution*
23	Democratization 1	Democratization 2	*Democratizing Engineering Models - Part 1*
24	Simulation Governance: Collaboration 1	Simulation Governance: Collaboration 2	Simulation Governance: Process Management
25A	Advanced Composites	Advanced Materials Characterization	Lightweighting
25B	Additive Manufacturing Process Analysis 1	Additive Manufacturing Process Analysis 2	Analysis & Certification of 3D Printed Parts
25C	Contacts, Joints, Welds & Connections 1	Contacts, Joints, Welds & Connections 2	Simulation of Manufacturing Methodologies & Processes: Welding
26A	CFD 1	CFD 2	CFD: Optimization
26B	Structural Analysis 1	Structural Analysis 2	Fatigue & Fracture
26C	Electrical 1	Electrical 2	*How to Improve Battery Performance by Digitally Optimizing the Microstructure of the Electrodes*

Presentations	*NAFEMS Training Course*	*Community Training/Workshop*

CAASE18 At-a-Glance Day 2 (*Wednesday, June 6th*)

Room	**2-1:** 10:50am - 12:35pm	**2-2:** 1:50pm - 3:35pm	**2-3:** 4:05pm - 6:00pm
20	*NAFEMS Training: CFD for Structural Designers & Analysts*	*NAFEMS Training: Practical Introduction to CFD*	*NAFEMS Training: Practical Modeling of Joints & Connections*
21	*Next Generation Discrete Element Modeling: Introduction and its Application*	*Material Simulation Based on Micro-Computed Tomography Data*	*Moving Beyond CAD - 3D Image-Based Simulation of Real World Geometries*
22	*Uncertainty Quantification with Complex Data*	*Additive Manufacturing Process Simulation Total Workflow*	*Catapulting Through Simulation Uncertainty with Model Calibration*
23	Democratization 3	Democratization 4	*Democratizing Engineering Models - Part 2*
24	Simulation Governance: Data Management 1	Simulation Governance: Data Management 2	Simulation Governance: Data Management 3
25A	*How to Use cdmHUB as a Cloud Collaboratory for Simulation*	*Two-Wheeled Scooter Dynamics: Strains and Load Reconstruction*	Full Product Performance Lifecycle (PPL)
25B	Product Design Based on Additive Manufacturing 1	Product Design Based on Additive Manufacturing 2	Product Design Based on Additive Manufacturing 3
25C	Nonlinear	Multiphysics 1	High-Performance Computing/Supporting Infrastructure
26A	Vibro-Acoustics	NVH	Acoustics
26B	Biomechanics	Medical Devices 1	Medical Devices 2
26C	Emerging Standards	Systems Simulation 1	Systems Simulation 2

Presentations	*NAFEMS Training Course*	*Community Training/Workshop*

CAASE18 At-a-Glance Day 3 (*Thursday, June 7th*)

Room	**3-1:** 10:20am - 12:05pm	**3-2:** 1:00pm - 2:45pm	**3-3:** 3:05pm - 4:55pm
20	*NAFEMS Training: Elements of Turbulence Modeling*	*NAFEMS Training: Nonlinear FEA*	*NAFEMS Training: Structural Optimization*
21	Multiphysics 2	Multiphysics 3	Multiphysics 4
22	*What's Wrong with Simulation, What Happens if It's Not Fixed, and How to Fix It!*	*Towards a Digital Twin*	*FMI-Based Collaborative Workflows*
23	Democratization 5	Democratization: Roundtable	Simulation Governance: Qualification of Simulation Personnel
24	Simulation Governance: Uncertainty Quantification	Simulation Governance: Verification & Validation 1	Simulation Governance: Verification & Validation 2
25A	ROI for Simulation Investment	Virtual/Augmented Reality	Advanced Information Technologies
25B	Simulation of Manufacturing Methodologies & Processes 1	Simulation of Manufacturing Methodologies & Processes 2	*VMAP:Defining Standards for Material Data Transfer in Manufacturing Virtual Simulation*
25C	*Cloud HPC Demystified: Best Practices of Executing and Managing Simulation Workloads on the Cloud*	*Introduction to Cloud Computing for Engineering Simulations with Hands-On Practice*	Cloud
26A	Optimization 2	Optimization 3	Optimization 4
26B	Medical Devices 3	Real-Time Simulation	CAD / CAE
26C	Reduced Order Modeling	Multibody Simulation 1	Multibody Simulation 2

Presentations	*NAFEMS Training Course*	*Community Training/Workshop*

AGENDA - Tuesday, June 5th

Day 1

Plenary Session: Grand Ballroom B

Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee

8:30 **Welcome & Introduction**

M. Ladzinski, Vice President, Americas & T. Morris, CEO, NAFEMS | T. Cooney, Publisher, Digital Engineering magazine

9:20 **Providing the Transformational Means to a New Era of Sustainability and Mobility**

P. Aversa, Chief Engineer - Global Powertrain NVH, Ford Motor Company

10:05 **Why Engineers Must Pay Serious Attention to Blockchain Technology**

D. Robles, Founder/Director, Integrated Engineering Blockchain Consortium

10:50 Break in the Exhibition Hall (Grand Ballroom C)

	Room 20	Room 21	Room 22	
11:20	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Multiscale** Chair: P. Prescott, Owens Corning Sci. & Tech.	**Optimization 1** Chair: E. Ladzinski, SMS_ThinkTank	***1***
	Dynamic FEA (Lvl: 2)	Submodeling of Thick-Walled Structures with Plasticity (K. Robinson, Southwest Research Institute; Lvl: 2)	Microstructure Optimization for NVH Improvement - Application to SFRP Engine Mount Bracket (K. Zouani, Ford Motor Company; Lvl:)	
		A 2040 Vision for Integrated, Multiscale Materials and System Modeling and Simulation (S. Arnold, NASA Glenn Research Center; Lvl: 1)	Multidisciplinary Design Optimization of a Winglet (M. Karve, Altair Engineering, Inc; Lvl:)	
		Large-Scale, HPC of Local Electrochemistry in Solid Oxide Fuel Cell Microstructures Based on Morphology-Preserving Meshes (Y. Hsu, Carnegie Mellon University; Lvl: 2)	Supercharging Design Engineering with HPC Workflow Automation (A. Khan, rLoop Incorporated; Lvl: 2)	
1:05	Lunch (Grand Ballroom A)			
2:20	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Community Training / Workshop**	**Community Training / Workshop**	***2***
	Fatigue & Fracture Mechanics in FEA (Lvl: 2)	Multiscale Modeling of Composite Structures Using Mechanics of Structure Genome (W. Yu, Purdue University; Lvl: 2)	Topology Optimization: Opportunities and Challenges (P. Yadav, SciArt, LLC; Lvl: 2)	
4:05	Break in the Exhibition Hall (Grand Ballroom C)			
4:35	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Community Training / Workshop**	**Community Training / Workshop**	***3***
	Composite FEA (Lvl: 2)	Introduction to Probabilistic Analysis and Uncertainty Quantification (M. Andrews, SmartUQ; Lvl: 1)	ASSESS Initiative: Collaborating with NAFEMS to Enable the Simulation Revolution (J. Walsh, intrinSIM LLC; Lvl: 1)	

6:20 Networking Reception in the Exhibiton Hall (Grand Ballroom C)

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

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10:50 Break in the Exhibition Hall (Grand Ballroom C)

	Room 23	Room 24	Room 25A	
11:20	**Democratization 1** Chair: D. Nagy, BeyondCAE	**Simulation Governance: Collaboration 1** Chair: L. Michalske, Procter & Gamble	**Advanced Composites** Chair: M. Felice, Ford Motor Company	**1**
	The Challenges and ROI of the Democratization of Simulation – Why Progress is Slow (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)	Open MBE: Removing Limitations (M. Kokaly, MSC Software; Lvl:)	Modeling Failure in Fiber-Reinforced Composite Tubes (F. Souza, MultiMechanics; Lvl: 2)	
	GPU Technology in the Cloud for Scalable and Democratized Engineering Simulations (R. Mitchell, ANSYS Inc.; Lvl:)	The Role of Simulation Governance in the Democratization of Simulation through the Use of Smart Sim Apps (R. Actis, ESRD, Inc.; Lvl: 3)	Multidisciplinary Analysis of Wind Turbine Blades (D. Seidensticker, MSC Software; Lvl: 1)	
	Democratization History at Accuride (M. McLeod, Accuride Corporation; Lvl: 1)	Enabling Non-expert Users Across the Enterprise to Discover Better Designs, Faster by Automating Design Exploration (R. Kashi, Siemens PLM Software; Lvl: 1)	Micromechanical Modeling and Simulation of a Multifunctional Hybrid Composite (C. Bauer, Math2Market GmbH; Lvl: 1)	

1:05 Lunch (Grand Ballroom A)

2:20	**Democratization 2** Chair: F. Popielas, SMS_ThinkTank	**Simulation Governance: Collaboration 2** Chair: R. Britto Maria, Embraer S.A.	**Advanced Materials Characterization** Chair: C. Roche, Western New England Univ.	**2**
	Taming the Wild Beast: Encapsulating Open-Source Software behind Democratization Framework (Z. Eckblad, Eckdyn Analysis Solutions; Lvl: 1)	Smart “3D CAE Report” for Making Faster Design Decisions throughout the Product Life Cycle (P. Mandava, Visual Collaboration Technologies Inc; Lvl: 1)	Simulation of Effect of Porosity on Properties of Synthetic Graphite (R. Paul, GrafTech International Holdings Inc.; Lvl: 2)	
	A Journey towards “Commoditization” of Simulation and Analysis IT Resources to Support “Democratization”... (A. Jaiswal, John Deere India Pvt Ltd; Lvl: 3)	Technology Tools Enabling Seismic Qualification of Equipment for Essential Building Applications (J. Gatscher, Schneider Electric North America; Lvl: 2)	Micromechanics Simulation Directly on CT Scans (K. Nigge, Volume Graphics GmbH; Lvl: 1)	
	Implementing the Democratization of Simulation at Zhongli (US & China) – The Goals, Challenges and Successes (J. Wu, Shanghai Zhongli Investment Co., Ltd.; Lvl:)	Excel is an Engineering Application, Too! The Challenges and Opportunities of Spreadsheets in Engineering (S. Dewhurst, EASA Software; Lvl: 2)	Micromechanical Modeling of the Role of Inclusions in High Cycle Fatigue Damage Initiation and Short Crack Growth (T. Frondelius, Wartsila Finland Oy; Lvl: 3)	

4:05 Break in the Exhibition Hall (Grand Ballroom C)

4:35	**Community Training / Workshop**	**Simulation Governance: Process Management** Chair: L. Michalske, Procter & Gamble	**Lightweighting** Chair: M. Felice, Ford Motor Company	**3**
	Democratizing Engineering Models - Part 1 (T. Valachovic, EASA Software; Lvl: 1)	Integrating Simulation into Requirements & System Engineering Work Processes (K. Comstock, Procter & Gamble; Lvl:)	Multimaterial Lightweighting Using Optimization-Led Design Software (A. Farahani, Engineering Technology Associates, Inc.; Lvl: 2)	
		An Investigation into the Suitability of Machine Learning Methodologies As a Supplement to Conventional Engineering Analysis (S. Dewhurst, EASA Software; Lvl: 2)	Integrated Comp. Materials Eng. Approach to Model Dev. and Vehicle Lightweighting with Advanced High Strength Steels (V. Savic, General Motors Corporation; Lvl: 1)	
		CAE Customization Options for Process Capture & Automation (J. Strain, Stress & Strain Technologies; Lvl: 2)		

6:20 Networking Reception in the Exhibiton Hall (Grand Ballroom C)

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AGENDA - Tuesday, June 5th

Day 1

Plenary Session: Grand Ballroom B

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9:20 **Providing the Transformational Means to a New Era of Sustainability and Mobility**

P. Aversa, Chief Engineer - Global Powertrain NVH, Ford Motor Company

10:05 **Why Engineers Must Pay Serious Attention to Blockchain Technology**

D. Robles, Founder/Director, Integrated Engineering Blockchain Consortium

10:50 Break in the Exhibition Hall (Grand Ballroom C)

	Room 25B	Room 25C	Room 26A	
11:20	**Additive Manufacturing Process Analysis 1** Chair: J. Strain, Stress & Strain Technologies	**Contacts, Joints, Welds & Connections 1** Chair: R. Keene, Consultant	**CFD 1** Chair: K. Fouladi, InfoMec Consulting	***1***
	Multi-Scale Modeling of Additive Manufacturing: From Process Simulation to Design Validation (D. Souza, e-Xstream Engineering LLC; Lvl:)	Contact Assembly Sequence Modeling (V. Narayanan, Siemens PLM Software; Lvl: 2)	Investigation of Random Extrusion Process through Computation Fluid Dynamics Simulation (L. Zhao, Pepsi Co; Lvl:)	
	In-situ Monitoring and Thermal Calculation of 3D Print Process (F. Abdi, AlphaSTAR Corporation; Lvl: 2)	Influence of Numerical Contact Formulation on Simulation of Natural Frequency (G. Westwater, Fisher Controls International LLC; Lvl: 2)	Confidence and Sensitivity of CFD Predictions of Control Valve Capacity (L. Novak, Fisher Controls International LLC; Lvl: 2)	
	Multiphysics Modeling of Layer Deposition Process and End Product Failure in Metal Additive Manufacturing (M. Senousy, ANSYS Inc.; Lvl: 2)	Large Assembly Modeling Using Glued Contact (H. Chang, MSC Software; Lvl: 2)	Traditional Compliance - A Barrier to Efficiency in Construction (B. Horsfall, BVT Engineering Professional Services; Lvl: 1)	

1:05 Lunch (Grand Ballroom A)

2:20	**Additive Manufacturing Process Analysis 2** Chair: J. Huang, Exco Engineering	**Contacts, Joints, Welds & Connections 2** Chair: J. Castro, The Boeing Company	**CFD 2** Chair: M. Reis, ESSS	***2***
	Applying Machine Learning to Additive Manufacturing to Analyze the Relationships between Manufacturing Process and Material Performance (A. Wang, Senvol; Lvl: 2)	Bolt Preload Modeling Methods (V. Narayanan, Siemens PLM Software; Lvl: 2)	CFD Simulation and Wind Tunnel Test Correlation for a Tailless Multi-Variant sUAS (H. Shah, Wichita State University; Lvl: 1)	
	Leveraging Thermal Simulations for Metal Additive Manufacturing Part Design & Qualification (B. Stucker, ANSYS; Lvl: 1)	Modeling the Impact of Joint Design on the Mechanical Performance of Graphite Electrode Columns (J. Glickstein, GrafTech International Holdings Inc.; Lvl: 2)	Dynamic Simulation Driven Fire PRA & Visualization at for Nuclear Power Plants (R. Sampath, Centroid LAB; Lvl:)	
	Uses and Applications of Additive Manufacturing Process Modeling (Z. Francis, ANSYS Inc.; Lvl:)	Quantifying Model Form Uncertainty in Welding Life Prediction Models Using Bayesian Framework for Axle Components (A. Vasu, American Axle Manufacturing; Lvl:)	Pressurized Air Tank Oil/Air Separation Efficiency Study (S. Sarkar, Caterpillar Inc.; Lvl: 2)	

4:05 Break in the Exhibition Hall (Grand Ballroom C)

4:35	**Analysis & Certification of 3D Printed Parts** Chair: J. Castro, The Boeing Company	**Simulation of Manuf. Methods: Welding** **Chair:** J. Ryatt, The Boeing Company	**CFD Optimization** Chair: K. Barthenheier, The Boeing Company	***3***
	Computed Tomography (CT) Based Inspection and Finite Element (FE) Simulation of Additive Manufactured (AM) Parts (K. Genc, Synopsys; Lvl: 2)	Welding Cloud Computational Applications for Digital Manufacturing (M. Shaxted, Parallel Works; Lvl: 2)	Dynamic CFD Study of a Low Leakage Subsea Valve (B. Kashid, Parker Hannifin Corporation- Hydraulic Valve Division; Lvl: 1)	
	Understanding Additive Manufactured Lattice Structures with Explicit Dynamics and Testing (D. Noviello, Autodesk Ltd.; Lvl: 2)	Residual Stress Modeling in Arc Welding of Low Carbon Steel Joints: A Numerical and Experimental Investigation (C. Souza, Pontifical Catholic University of Rio de Janeiro; Lvl: 2)	CFD-Based Optimization of Micro Vortex Diodes (K. Fouladi, InfoMec Consulting; Lvl: 2)	
		Simulations of Melt Pool Dynamics in Laser Powder Fusion Processes (P. Allu, Flow Science Inc.; Lvl: 2)		

6:20 Networking Reception in the Exhibiton Hall (Grand Ballroom C)

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Tuesday, June 5th

Day 1

Plenary Session: Grand Ballroom B

Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee

8:30	**Welcome & Introduction** M. Ladzinski, Vice President, Americas & T. Morris, CEO, NAFEMS | T. Cooney, Publisher, Digital Engineering magazine
9:20	**Providing the Transformational Means to a New Era of Sustainability and Mobility** P. Aversa, Chief Engineer - Global Powertrain NVH, Ford Motor Company
10:05	**Why Engineers Must Pay Serious Attention to Blockchain Technology** D. Robles, Founder/Director, Integrated Engineering Blockchain Consortium
10:50	Break in the Exhibition Hall (Grand Ballroom C)

	Room 26B	Room 26C	**Exhibition Hall** Grand Ballroom C	
11:20	**Structural Analysis 1** Chair: C. Pieper, Kimberly-Clark Corporation	**Electrical 1** **Chair:** T. Morris, NAFEMS		1
	Parametric FEM for Dynamic Response Modeling of Plates Partially Covered with Constrained Layer Damping Treatment (Y. Ozcelik, Borusan Teknoloji Gelistirme ve Arge AS.; Lvl: 3)	Fast Charging – An Attractive Option for EVs Owners with Range Anxiety (W. Du, Siemens PLM Software; Lvl: 2)		
	Increasing Predictability in Simulations of Thermoplastic Airbag Module Components Using Plasticity & Failure Model Characterization... (A. Ortega, Joyson Safety Systems; Lvl: 2)	Simulation of Electromagnetic Effects in Urban Environment (L. Gritter, AltaSim Technologies LLC; Lvl:)	***OPEN***	
	Tire Performance Simulation (J. Wang, ANSYS Inc.; Lvl: 2)			
1:05	Lunch (Grand Ballroom A)			
2:20	**Structural Analysis 2** Chair: G. Elliott, Bombardier Aerospace	**Electrical 2** Chair: G. Allen, Rite - Solutions, Inc.		2
	A Gradient-Regularized Coupled Damage-Plasticity Microplane Model for Concrete-Like Materials (G. Lin, ANSYS Inc.; Lvl: 3)	EV Drive-Cycle Performance: Optimization and Thermal Analysis (M. Anders, Siemens Industry Software GmbH; Lvl: 1)		
	Frictional Forces in Oils Well Casing Strings by Using FEA (F. Godoy, Engineering Systems Inc. (ESI); Lvl: 2)	How Does the Microstructure of the Cathode Material Influence the Performance of the Battery? (I. Glatt, Math2Market GmbH; Lvl: 1)	***OPEN***	
4:05	Break in the Exhibition Hall (Grand Ballroom C)			
4:35	**Fatigue & Fracture** Chair: G. Elliott, Bombardier Aerospace	**Community Training / Workshop**		3
	SMART Method for Automatic Simulation of Static and Fatigue Crack Growth (G. Lin, ANSYS Inc.; Lvl: 3)	How to Improve Battery Performance by Digitally Optimizing the Microstructure of the Electrodes (I. Glatt, Math2Market GmbH; Lvl: 1)		
	Life Prediction Modeling Capabilities for FE Applications (A. Loghin, Simmetrix Inc.; Lvl: 2)		***OPEN***	
	Introduction to Material Force for Fracture Application (G. Lin, ANSYS Inc.; Lvl: 3)			
6:20	Networking Reception in the Exhibiton Hall (Grand Ballroom C)			

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Wednesday, June 6th   Day 2

	Plenary Session: Grand Ballroom B
	Chair: T. Morris, CEO, NAFEMS
8:30	**Welcome & Introduction**
	M. Ladzinski, Vice President, Americas, NAFEMS
8:50	**Accelerating Innovation through Collaboration**
	C. Nowinski Collens, CEO, UI Labs
9:35	**AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant**
	J. Overton, Data Scientist, DXC Technology
10:20	Break in the Exhibition Hall (Grand Ballroom C)

	Room 20	Room 21	Room 22	
10:50	**NAFEMS Training** Instructor: K. Fouladi, NAFEMS	**Community Training / Workshop**	**Community Training / Workshop**	***1***
	CFD for Structural Designers & Analysts (Lvl: 1)	Next Generation Discrete Element Modeling: Introduction and Its Application (S. Sarkar, ESSS; Lvl:)	Uncertainty Quantification with Complex Data (M. Andrews, SmartUQ; Lvl: 2)	
12:35	Lunch (Grand Ballroom A)			
1:50	**NAFEMS Training** Instructor: K. Fouladi, NAFEMS	**Community Training / Workshop**	**Community Training / Workshop**	***2***
	Practical Introduction to CFD (Lvl: 1)	Material Simulation Based on Micro-Computed Tomography Data (C. Bauer, Math2Market GmbH; Lvl: 1)	Additive Manufacturing Process Simulation Total Workflow (C. Robinson, ANSYS; Lvl: 1)	
3:35	Break in the Exhibition Hall (Grand Ballroom C)			
4:05	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Community Training / Workshop**	**Community Training / Workshop**	***3***
	Practical Modeling of Joints & Connections (Lvl: 2)	Moving Beyond CAD - 3D Image-Based Simulation of Real World Geometries (K. Genc, Synopsys; Lvl: 1)	Catapulting Through Simulation Uncertainty with Model Calibration (M. Andrews, SmartUQ; Lvl: 2)	
6:00	Rock & Roll Night Out at the Rock & Roll Hall of Fame			

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AGENDA - Wednesday, June 6th

Day 2

	Plenary Session: Grand Ballroom B
	Chair: T. Morris, CEO, NAFEMS
8:30	**Welcome & Introduction**
	M. Ladzinski, Vice President, Americas, NAFEMS
8:50	**Accelerating Innovation through Collaboration**
	C. Nowinski Collens, CEO, UI Labs
9:35	**AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant**
	J. Overton, Data Scientist, DXC Technology
10:20	Break in the Exhibition Hall (Grand Ballroom C)

	Room 23	Room 24	Room 25A	
10:50	**Democratization 3** Chair: C. Pieper, Kimberly-Clark Corporation	**Simulation Governance: Data Management 1** Chair: L. Michalske, The Procter & Gamble Co.	**Community Training / Workshop**	**1**
	Implementing Rules-Based Simulation Automation for Democratizing Automotive Wheel Design – The Goals, Challenges and Successes (T. Hood, Superior Industries; Lvl:)	Advanced Results Compression Combined with a Sophisticated and Out-of-the-Box SDM System: A Case Implemented at Honda (A. Perifanis, BETA CAE Systems SA; Lvl: 2)	How to Use cdmHUB as a Cloud Collaboratory for Simulation-Based Composites Design and Manufacturing (W. Yu, Purdue University; Lvl: 1)	
	Enabling Democratization By Engineers, For Engineers (J. Aldred, HBM Prenscia nCode; Lvl: 1)	Leverage Aircraft Structures Design with Engineering Collaboration (P. Grimberg, Digital Product Simulation; Lvl: 2)		
	Towards CFD Democratization in Pre-development (T. Papadopoulos, Siemens AG; Lvl: 2)	Modularization of FEA Models as Key Enabler for Simulation Data Management (C. Wang, General Motors Corporation; Lvl: 3)		
12:35	Lunch (Grand Ballroom A)			
1:50	**Democratization 4** Chair: M. Reis, ESSS	**Simulation Governance: Data Management 2** Chair: J. Castro, The Boeing Company	**Community Training / Workshop**	**2**
	A Business Centric Approach to Simulation Democratization (J. Betts, Front End Analytics LLC; Lvl:)	Uncertainty Quantification and Digital Engineering Applications in Design and Life Cycle Management (K. O'Flaherty, SmartUQ; Lvl: 2)	Two-Wheeled Scooter Dynamics: Strains and Load Reconstruction (T. Hunter, Wolf Star Technologies; Lvl:)	
	Wind ITO Fulfillment Center: Capturing Proprietary Processes for Wind Farm Siting Analysis (M. Kornfein, GE Global Research & Development; Lvl: 1)	An Efficient Database Schema for Capturing Stochastic Material Performance Data Using Probability Distribution Models (F. Holland, NASA Glenn Research Center; Lvl: 1)		
	Simulation Data Management and Process Automation at Beijing Institute of Space Mechanics and Electricity (BISME) – Goals and Successes (Y. Yang, BISME; Lvl:)	Frontloading Process in Powertrain Development - Virtual Design Release (E. Tan, AVL Advanced Simulation Technologies; Lvl: 1)		
3:35	Break in the Exhibition Hall (Grand Ballroom C)			
4:05	**Community Training / Workshop**	**Simulation Governance: Data Management 3** Chair: F. Popielas, SMS_ThinkTank	**Full Product Performance Lifecycle (PPL)** Chair: G. Elliott, Bombardier Aerospace	**3**
	Democratizing Engineering Models – Part 2: Evaluating 3-D CAD Designs (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)	Simulation-Driven Engineering and Its Role in the Product Development Process (R. Ramkumar, Dana Holding Corporation; Lvl:)	Benefits of Industrial X-Ray and Computed Tomography (CT) Technology in the Advancement of Analysis and Simulation in Engineering (J. Topich, Kinetic Vision; Lvl: 1)	
		Requirement and Task Management as a Part of Wartsila Digital Design Platform (J. Konno, Wartsila Finland Oy; Lvl: 2)	The Emerging Key Role of Simulation in the Full Product Performance Lifecycle (PPL) (D. Nagy, BeyondCAE; Lvl: 2)	
		One Ring to Rule Them All: Managing Simulation Projects across Multiple Tools and Software into One Efficient Solution (M. Sullivan, Adaptive Corporation; Lvl: 2)		
6:00	Rock & Roll Night Out at the Rock & Roll Hall of Fame			

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Wednesday, June 6th Day 2

	Plenary Session: Grand Ballroom B
	Chair: T. Morris, CEO, NAFEMS
8:30	**Welcome & Introduction**
	M. Ladzinski, Vice President, Americas, NAFEMS
8:50	**Accelerating Innovation through Collaboration**
	C. Nowinski Collens, CEO, UI Labs
9:35	**AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant**
	J. Overton, Data Scientist, DXC Technology
10:20	Break in the Exhibition Hall (Grand Ballroom C)

	Room 25B	Room 25C	Room 26A	
10:50	**Product Design Based on Add. Manufacturing 1** Chair: K. Barthenheier, The Boeing Company	**Nonlinear** **Chair:** C. Roche, Western New England Univ.	**Vibro-Acoustics** Chair: J. Strain, Stress & Strain Technologies	**1**
	Simplified Modeling for Thermal Stress Analysis of Conformal Cooling Line in Die Casting Die (J. Huang, Exco Engineering; Lvl: 2)	3D Automatic Mesh Nonlinear Adaptivity (NLAD) Using Quadratic Tetrahedral Elements (S. Mukherjee, ANSYS Inc.; Lvl: 3)	A Vibro-Acoustics Approach for Driveshaft Clunk Sound Prediction (M. Felice, Ford Motor Company; Lvl: 2)	
	Computational Analysis of Components Produced by Fused Deposition Modeling, and the Importance of Print Orientation (P. Brayford, Syncroness; Lvl: 1)	Nonlinear Fracture Mechanics Applications in Bridge Design (J. Calisto da Silva, STV Inc.; Lvl:)	A Model Order Reduction Scheme for Frequency Dependent Vibro-Acoustic Applications (B. Liao, Siemens PLM Software; Lvl: 2)	
	Evolution of NuStep Exercise Machine Sickle Design Utilizing Optimization and Additive Manufacturing (R. Hurlston, Caelynx LLC; Lvl:)		Vibro-Acoustic Analysis of a Permanent Magnet Machine for Electrical Vehicles (K. Illa, Siemens PLM Software; Lvl:)	
12:35	Lunch (Grand Ballroom A)			
1:50	**Product Design Based on Add. Manufacturing 2** Chair: J. Huang, Exco Engineering	**Multiphysics 1** Chair: P. Prescott, Owens Corning Sci. & Tech.	**NVH** Chair: R. Keene, Consultant	**2**
	Managing Metal AM Process Variability Through FEA Based Testing and Controls (A. Buijk, Simufact-Americas LLC; Lvl: 1)	The Use of Multiphysics Simulation in The Design of Commercial Air Package Delivery Systems (L. Salman, ANSYS Canada Ltd.; Lvl: 1)	Vibration and Radiated Noise Simulation of Engine Gear Rattle and Whine (M. Felice, Ford Motor Company; Lvl: 2)	
	Cognitive Generative Design (M. Bogomolny, ParaMatters Inc; Lvl: 1)	A New Multiphysics Technology for Tire Hydroplaning Simulations (B. Nandi, Dassault Systèmes SIMULIA Corp; Lvl: 3)	Gear Whine of Planetary Gear Systems (W. Röver, Dassault Systemes SIMULIA Corp.; Lvl: 2)	
	Generative Design of Lightweight Lattice Structures with Additive Manufacturing Constraints (D. Weinberg, Autodesk Inc.; Lvl: 2)	Robust FEM-BEM Coupling for Electromagnetic Field Computations and Multiphysics Problems (T. Rüberg, TailSit GmbH; Lvl:)	Efficient Simulation of Automotive Driveline System NVH (Z. Sun, American Axle Manufacturing; Lvl:)	
3:35	Break in the Exhibition Hall (Grand Ballroom C)			
4:05	**Product Design Based on Add. Manufacturing 3** Chair: J. Walsh, intrinSIM	**HPC / Supporting Infrastructure** Chair: G. Allen, Rite - Solutions, Inc.	**Acoustics** Chair: J. Cox, Honda R&D Americas, Inc.	**3**
	Design-Build-Test: Closing the Loop on Generative Design + Additive Manufacturing (D. Noviello, Autodesk Ltd.; Lvl: 2)	The Effect of In-networking Computing Capable Interconnects on the Scalability of CAE Simulations (O. Maor, HPC Advisory Council; Lvl: 2)	Field Meta-Model Based Multi-Objective Shape Optimization of 3-Pass Exhaust Muffler (P. Som, Ansys India; Lvl: 2)	
	Additive Manufacturing Process Simulation and Generative Design – Production of Functional Parts (A. Chakraborty, VIAS; Lvl: 1)	Accurate Interactive 3D Engineering Simulations Accelerated by GPUs (T. Papadopoulos, Siemens AG; Lvl: 2)	Spectral Analysis of Aeroacoustic Noise Using CAE Tools (P. Som, Ansys India; Lvl: 2)	
	Part Design by Simulation (R. Helfrich, INTES GmbH; Lvl: 2)	CAE Goes Mainstream with GPU-Accelerated Computing (B. Rajagopalan, NVIDIA; Lvl: 1)		
6:00	Rock & Roll Night Out at the Rock & Roll Hall of Fame			

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Wednesday, June 6th — Day 2

Time	Room 26B	Room 26C	Exhibition Hall
	Plenary Session: Grand Ballroom B Chair: T. Morris, CEO, NAFEMS		
8:30	**Welcome & Introduction** M. Ladzinski, Vice President, Americas, NAFEMS		
8:50	**Accelerating Innovation through Collaboration** C. Nowinski Collens, CEO, UI Labs		
9:35	**AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant** J. Overton, Data Scientist, DXC Technology		
10:20	Break in the Exhibition Hall (Grand Ballroom C)		**Exhibition Hall** Grand Ballroom C
	Room 26B	**Room 26C**	
10:50	**Biomechanics** Chair: D. Nagy, BeyondCAE	**Emerging Standards** Chair: F. Popielas, SMS_ThinkTank	1
	Effects of Insole-to-Midsole Heel Height on the Plantar Stress: A Finite Element Analysis (M. Kia, Caelynx LLC; Lvl:)	Emerging Standards for Model-Based Systems Engineering (D. Tolle, CIMdata Inc; Lvl: 2)	
	Brain Bulging: A Personalised Model (K. Genc, Synopsys; Lvl: 2)	Custom Integration Framework for MBSE and CAE Using Open Standards (A. Shah, John Deere; Lvl: 2)	***OPEN***
	Finite Element Modeling as a Computational Approach to Study Biomechanics of Short Bowel Syndrome (S. Hosseini, Stanford University; Lvl: 2)	LOTAR EAS and International Standards and How It Relates to Advancing Analysis and Simulation in Engineering (J. Castro, LOTAR Engineering Analysis and Simulation Working Group; Lvl:)	
12:35	Lunch (Grand Ballroom A)		
1:50	**Medical Devices 1** Chair: J. Walsh, intrinSIM	**Systems Simulation 1** Chair: L. Michalske, The Procter & Gamble Co.	2
	Modeling and Simulation Bring Deep Understandings of Medical Products to Improve Patient Experience (N. Song, Abbvie Inc.; Lvl:)	System Engineering for the Mass via Canonical Systems Model (B. Sherman, The Procter & Gamble Co.; Lvl:)	
	Giving Arthritis the Finger: Customized Medical Device, Optimized for Durability (R. Stupplebeen, Optimal Device; Lvl: 2)	Integrating FEA Physics Models with System Engineering (J. Szarazi, Koneksys; Lvl: 2)	***OPEN***
	Numerical Analysis of Transcatheter Aortic Valve Performance: The Effect of Heart Beating and Blood Flow (R. Ghosh, Stony Brook University; Lvl: 1)	Systems Engineering – Challenges for Management (F. Popielas, SMS_Thinktank; Lvl: 2)	
3:35	Break in the Exhibition Hall (Grand Ballroom C)		
4:05	**Medical Devices 2** Chair: M. Heller, ASME	**Systems Simulation 2** Chair: E. Ladzinski, SMS_ThinkTank	3
	Using Computational Fluid Dynamics to Predict the Effects of a Mandibular Repositioning Device on the Airway of Patients with Obstructive Sleep Apnea (M. Goodin, SimuTech Group; Lvl: 2)	Optimizing the Design of Liquid Cooled Avionics System through the Use of Characterized 3D CFD Simulations in a 1D System Simulation (M. Croegaert, Mentor Graphics Corporation; Lvl: 2)	
	Personalized Cardiovascular Modeling for Medical Device Efficacy, Drug Safety, and Clinical Guidance (K. D'Souza, Dassault Systèmes SIMULIA Corp; Lvl:)	Mechanical System Simulation Opportunities Using Combined Multibody Dynamics and Particle-Based CFD (S. Kim, FunctionBay, Inc; Lvl: 1)	***OPEN***
6:00	Rock & Roll Night Out at the Rock & Roll Hall of Fame		

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Thursday, June 7th — Day 3

	Plenary Session: Grand Ballroom B Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee
8:00	**Welcome & Introduction** M. Ladzinski, Vice President, Americas, NAFEMS
8:20	**Requirements of Certification by Analysis** P. Safarian, P.E., Fatigue and Damage Tolerance Senior Technical Specialist, FAA
9:05	**Priorities Advancing Regulatory Science and In Silico Medicine at the FDA** T. Morrison, Deputy Director, Division of Applied Mechanics, Office of Science and Engineering Laboratories, U.S. FDA
9:50	Break in the Exhibition Hall (Grand Ballroom C)

	Room 20	Room 21	Room 22	
10:20	**NAFEMS Training** Instructor: K. Fouladi, NAFEMS	**Multiphysics 2** Chair: M. Felice, Ford Motor Company	**Community Training / Workshop**	***1***
	Elements of Turbulence Modeling (Lvl: 2)	MOOSE Framework Overview and BISON Application Demonstration (A. Casagranda, Idaho National Laboratory; Lvl: 2)	What's Wrong with Simulation, What Happens if It's Not Fixed, and How to Fix It (M. Zebrowski, Consultant (Ford Motor Company, Retired); Lvl:)	
		Design Optimization of a Piping System for Fatigue and Strength Using Coupled FEA and CFD Simulation Techniques (B. Ozturk, VIAS; Lvl:)		
		Multiphysics Modeling of Particle Separation Using Acoustophoresis (N. Elabbasi, Veryst Engineering LLC; Lvl: 3)		
12:05	Lunch (Grand Ballroom A)			
1:00	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Multiphysics 3** Chair: C. Roche, Western New England Univ.	**Community Training / Workshop**	***2***
	Nonlinear FEA (Lvl: 2)	Simulation Guided Packaging Designs for a Flavor Delivery System (A. Warning, Pepsi Co; Lvl: 2)	Towards a Digital Twin (I. Shibata, Altair Japan; Lvl: 1)	
		Simulation of a Vibrational Scalpel (K. Koppenhoefer, AltaSim Technologies LLC; Lvl:)		
		Using Reduced Order Modeling and Multiphysics Simulation to Predict Product Failures and Develop Smart Preventive Maintenance Programs (A. Jatale, ANSYS Inc.; Lvl: 3)		
2:45	Break (Pre-Function Area)			
3:05	**NAFEMS Training** Instructor: T. Abbey, NAFEMS	**Multiphysics 4** Chair: P. Prescott, Owens Corning Sci. & Tech.	**Community Training / Workshop**	***3***
	Structural Optimization (Lvl: 2)	Simulation of Atmospheric Air Plasma (J. Crompton, AltaSim Technologies LLC; Lvl:)	FMI-Based Collaborative Workflows (H. Tummescheit, Modelon; Lvl: 1)	
		Modeling and Digital Image Correlation of Crack Growth in Graphite Electrodes (N. May, GrafTech International Holdings Inc.; Lvl: 2)		
		Large Scale Discrete Element Modeling for Various Process Equipment (S. Sarkar, ESSS; Lvl:)		
4:55	CAASE18 Wrap-Up Presentation & Close (Grand Ballroom B) Presented by R. Dreisbach, NAFEMS Council and Chair of the Americas Steering Committee			

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

AGENDA - Thursday, June 7th

Day 3

Plenary Session: Grand Ballroom B

Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee

8:00 **Welcome & Introduction**

M. Ladzinski, Vice President, Americas, NAFEMS

8:20 **Requirements of Certification by Analysis**

P. Safarian, P.E., Fatigue and Damage Tolerance Senior Technical Specialist, FAA

9:05 **Priorities Advancing Regulatory Science and In Silico Medicine at the FDA**

T. Morrison, Deputy Director, Division of Applied Mechanics, Office of Science and Engineering Laboratories, U.S. FDA

9:50 Break in the Exhibition Hall (Grand Ballroom C)

	Room 23	Room 24	Room 25A	
10:20	**Democratization 5** Chair: C. Pieper, Kimberly-Clark Corporation	**Sim. Gov: Uncertainty Quantification** Chair: J. Castro, The Boeing Company	**ROI for Simulation Investment** Chair: R. Britto Maria, Embraer S.A.	*1*
	Assessment of Gearbox Durability Using a Customized App (Y. Marchand, Romax Technology Inc; Lvl: 1)	Uncertainty Quantification with Missing Values (M. Andrews, SmartUQ; Lvl: 3)	How to Make the Most of Your Analysis and Simulation Applications (L. Cole, Open iT; Lvl: 2)	
	Implementing the Democratization of Simulation at ZPMC – The Goals, Challenges and Successes (L. Yiming, ZPMC; Lvl:)	Modeling and Simulation/Verification & Validation in Advanced Manufacturing (M. Heller, ASME; Lvl: 1)		
	RevolutionInSimulation.org – a new, public Web Community for the Democratization of Simulation (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)			

12:05 Lunch (Grand Ballroom A)

1:00	**Democratization: Roundtable** Chair: Revolution in Simulation	**Sim. Gov.: Verification & Validation 1** Chair: T. Morrison, FDA	**Virtual / Augmented Reality** Chair: J. Strain, Stress & Strain Technologies	*2*
	Democratization Roundtable Discussion/Q&A (M. Panthaki, Revolution in Simulation, Inc.; Lvl: 2)	Digital Characterization of the Injection Molding Process – Verification and Validation (J. Sengupta, Hoerbiger Corporation of America, Inc.; Lvl:)	Are Virtual and Augmented Reality the Next Mouse and GUI? (J. Jarrett, Kinetic Vision; Lvl: 1)	
		Model-Driven Engineering & Virtual Validation: Towards Design for Digital Twin (U. Abusomwan, Schlumberger; Lvl: 2)	A Unified Environment for Collaborative CAE and Immersive Simulation Results' Processing (S. Kleidarias, BETA CAE Systems SA; Lvl: 2)	
		Assessing Credibility of Computational Models through Verification and Validation: Application to Medical Devices (L. Knudsen, Syncroness; Lvl: 2)		

2:45 Break (Pre-Function Area)

3:05	**Sim. Gov.: Qualification of Simulation Personnel** Chair: J. Castro, The Boeing Company	**Sim. Gov.: Verification & Validation 2** Chair: T. Morrison, FDA	**Advanced Information Technologies** Chair: R. Britto Maria, Embraer S.A.	*3*
	The University's Role in Addressing the Skills Gap and Preparing Individuals for CAE: Continuous Learning and Workforce Development (E. Nutwell, The Ohio State University; Lvl: 1)	Accuracy of Predicting Stress Concentration Factors (C. Roche, PE, Western New England University; Lvl: 1)	Optimization: From Generative to Human-Assisted Design, and Machine Learning (K. Meintjes, CIMdata Inc; Lvl: 2)	
	Challenges and Rewards of Integrating Computer Aided Engineering in Undergraduate Engineering Experience (S. Noll, The Ohio State University; Lvl:)	Using Statistical Calibration for Model Verification and Validation, Diagnosis of Model Inadequacy and Improving Simulation Accuracy (K. O'Flaherty, SmartUQ; Lvl: 3)	The Deep Learning Revolution and Its Impact on Computer Aided Engineering (S. Slavetinsky, Renumics GmbH; Lvl: 1)	
	Taking Simulation to the Next Level - Finite Element Model and Engineer (R. Zanoni, Siemens Gamesa Renewable Energy B.V.Brunel Netherlands; Lvl: 1)		Simulation Solver Meshing in Graph Representation (J. Xie, ANSYS; Lvl: 3)	

4:55 CAASE18 Wrap-Up Presentation & Close (Grand Ballroom B) Presented by R. Dreisbach, NAFEMS Council and Chair of the Americas Steering Committee

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AGENDA - Thursday, June 7th

Day 3

	Plenary Session: Grand Ballroom B Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee
8:00	**Welcome & Introduction** M. Ladzinski, Vice President, Americas, NAFEMS
8:20	**Requirements of Certification by Analysis** P. Safarian, P.E., Fatigue and Damage Tolerance Senior Technical Specialist, FAA
9:05	**Priorities Advancing Regulatory Science and In Silico Medicine at the FDA** T. Morrison, Deputy Director, Division of Applied Mechanics, Office of Science and Engineering Laboratories, U.S. FDA
9:50	Break in the Exhibition Hall (Grand Ballroom C)

	Room 25B	Room 25C	Room 26A	
10:20	**Simulation of Manuf. Method. & Processes 1** Chair: G. Allen, Rite - Solutions, Inc.	**Community Training / Workshop**	**Optimization 2** Chair: J. Betts, Front End Analytics	*1*
	Simulating Laser Powder Bed Fusion Processes Using the Multiscale Method (E. Denlinger, Autodesk; Lvl: 2)	Cloud HPC Demystified: Best Practices of Executing and Managing Simulation Workloads on the Cloud (R. Combier, Rescale; Lvl: 2)	Data Driven Design Optimization and Application Based on Small Sampling Learning (G. Wang, Empower Operations Corp; Lvl: 1)	
	Injection Molding Process Simulation during the Development of a Laundry Centre Tub (J. Anaya, Mabe S.A. de C.V.; Lvl: 1)		Design Optimization of Safety Critical Component for Fatigue and Strength Using Simulation and Data Analytics (A. Chakraborty, VIAS; Lvl: 2)	
	An Overview of Mathematical Modeling and Numerical Simulation in Glass Fiber Manufacturing (P. Prescott, Owens Corning Science & Technology; Lvl: 2)		Multidisciplinary Car Body Optimization for Balanced Design Weight, Cost and Vehicle Performance (L. Fredriksson, Altair Engineering GmbH; Lvl:)	
12:05	Lunch (Grand Ballroom A)			
1:00	**Simulation of Manuf. Method. & Processes 2** Chair: J. Huang, Exco Engineering	**Community Training / Workshop**	**Optimization 3** Chair: J. Walsh, intrinSIM	*2*
	Tolerance Analysis - An Engineering Simulation of Production and Performance Quality (C. Wilkes, Sigmetrix; Lvl:)	Introduction to Cloud Computing for Engineering Simulations – With Hands-On Practice (W. Gentzsch, UberCloud; Lvl: 2)	Optimizing Part Geometry with Constraints for Manufacturing (W. Thomas, TechnipFMC; Lvl:)	
	High Speed Multi-Ridged Nailing Process Simulation Using SPG Method (T. Luscher, The Ohio State University; Lvl:)		Multidisciplinary Topology and Parametric Optimization of a BiW, Following a Unique Holistic Process (A. Kaloudis, BETA CAE Deutschland GmbH; Lvl:)	
	Efficient Modeling and Simulation of Welding Processes (M. Pandheeradi, Dassault Systemes SIMULIA Corp; Lvl: 2)		Robust Design by Optimization under Reliability Constraints (R. Helfrich, INTES GmbH; Lvl: 1)	
2:45	Break (Pre-Function Area)			
3:05	**Community Training / Workshop**	**Cloud** Chair: D. Nagy, BeyondCAE	**Optimization 4** Chair: K. Barthenheier, The Boeing Company	*3*
	ITEA VMAP – A New Interface Standard for Integrated Virtual Material Modelling in Manufacturing Industry (A. Floyd, Convergent Manufacturing Technologies Inc; Lvl: 2)	Roadmap to Adopting Private or Public Cloud Simulation as a Service (R. Mach, TotalCAE; Lvl: 2)	Reducing Engine Block Bore Distortion Using Topology Optimization (G. Mudigonda Kuravi, Altair Engineering Inc.; Lvl: 1)	
		Novel Software Container Technology Enabling Ease of Access and Use of CAE Applications in the Private and Public Cloud (W. Gentzsch, UberCloud; Lvl: 2)	Topology Optimization and Casting Feasibility of a Robot Arm (P. Hiremath, Altair Engineering, Inc; Lvl: 2)	
		Simulation as a Service in the Cloud (A. Luz, Infinite Foundry; Lvl: 1)		
4:55	CAASE18 Wrap-Up Presentation & Close (Grand Ballroom B) Presented by R. Dreisbach, NAFEMS Council and Chair of the Americas Steering Committee			

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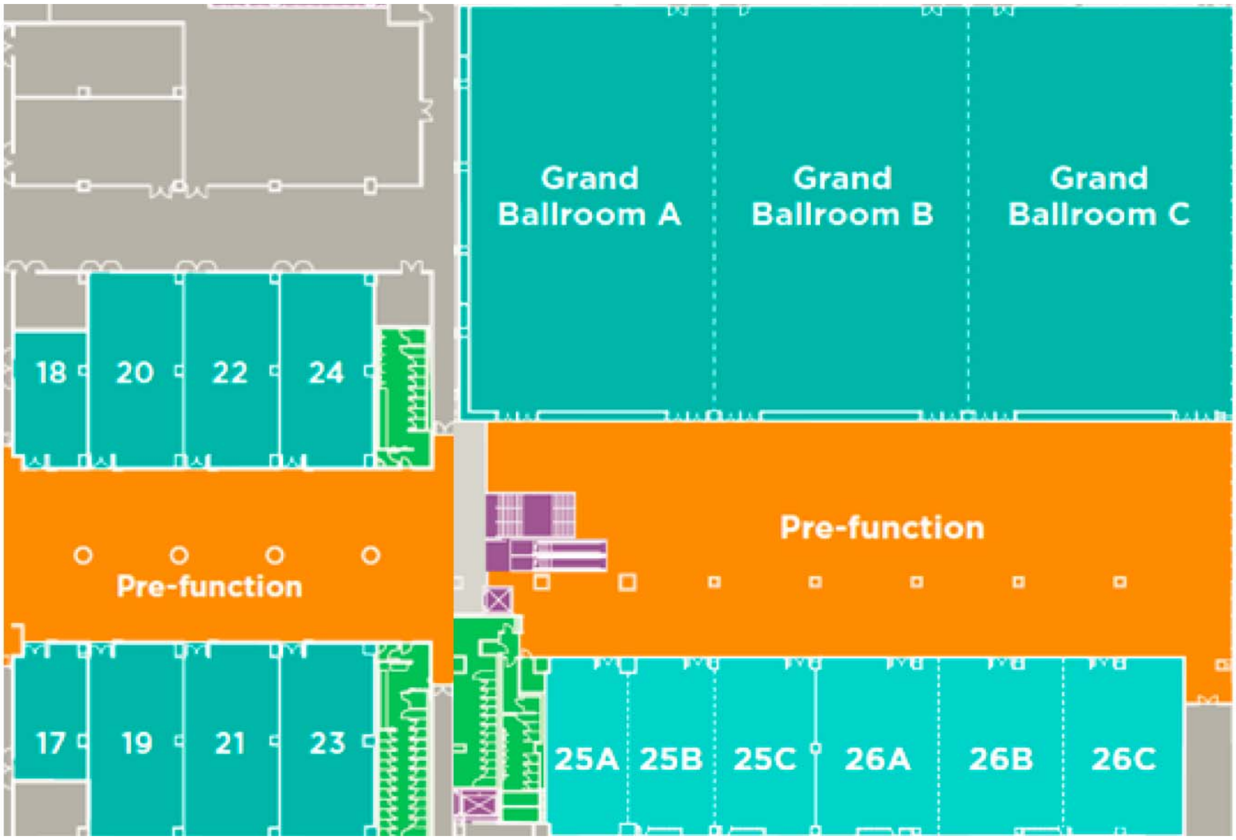
AGENDA - Thursday, June 7th   Day 3

	Plenary Session: Grand Ballroom B		
	Chair: R. Dreisbach, Independent Engineering Consultant (Boeing Retiree), NAFEMS Council Member and Chairman of the Americas Steering Committee		
8:00	**Welcome & Introduction** M. Ladzinski, Vice President, Americas, NAFEMS		
8:20	**Requirements of Certification by Analysis** P. Safarian, P.E., Fatigue and Damage Tolerance Senior Technical Specialist, FAA		
9:05	**Priorities Advancing Regulatory Science and In Silico Medicine at the FDA** T. Morrison, Deputy Director, Division of Applied Mechanics, Office of Science and Engineering Laboratories, U.S. FDA		
9:50	Break in the Exhibition Hall (Grand Ballroom C)		**Exhibition Hall** Grand Ballroom C
	Room 26B	**Room 26C**	
10:20	**Medical Devices 3** Chair: T. Morrison, FDA	**Reduced Order Modeling** Chair: R. Keene, Consultant	***OPEN***
	Total Artificial Heart Computational Fluid Dynamics Modeling - Gaining Insight to Reduce the Potential for Thrombus Formation (M. Goodin, SimuTech Group; Lvl: 2)	ROM Based Sensitivity Assessment of Thermo-Mechanical Fatigue Life of Exhaust Manifold Subjected to Uncertainties in Material, Loading and Manufacturing (P. Som, Ansys India; Lvl: 3)	
	Blood Flow Modeling in a Beating Human Heart with Applications in Medical Device Design and Patient Care (K. D'Souza, Dassault Systèmes SIMULIA Corp; Lvl:)	Evaluation of the Nonlinear Mechanical Response in Threaded Fasteners (P. Grimmer, Sandia National Labs; Lvl: 2)	
	Virtual Testing of Total Knee Arthroplasty Component Performance (E. Morra, Orthopaedic Research Laboratories; Lvl: 1)		
12:05	Lunch (Grand Ballroom A)		
1:00	**Real-Time Simulation** Chair: C. Cummings, Honda R&D Americas	**Multibody Simulation 1** Chair: G. Elliott, Bombardier Aerospace	
	New Opportunities for Customers Using Simulation Realtime (R. Solomon, Dassault Systemes SIMULIA; Lvl:)	On the Correct Preloading of Nonlinear Flexible Bodies to Achieve Accurate Multibody Simulation Results (B. Ross, MotionPort; Lvl: 1)	
	Engineering Analytics for the Automotive Industry (K. O'Flaherty, SmartUQ; Lvl: 2)	NASA Langley Pendulum Swing-Drop Dynamic System (R. Wagner, NASA Langley Research Center; Lvl: 1)	
	Dynamic Load Calculation and Correlation of Aluminum Truck Body for Knapheide Mfg Co. (C. Murphy, Adaptive Corporation; Lvl: 2)	A Simulation Methodology for the Design of Trailing-Edge Flap Deployment Mechanism (A. ÖNGÜT, Siemens Industry Software NV; Lvl: 2)	
2:45	Break (Pre-Function Area)		
3:05	**CAD / CAE** Chair: G. Allen, Rite - Solutions, Inc.	**Multibody Simulation 2** **Chair:** K. Zouani, Ford Motor Company	
	Rapid CAD Generation and Optimization for Vehicle Design and CAE Engineers (R. Makwana, Detroit Engineered Products; Lvl: 2)	Design and Development of an Optimal Fault Tolerant 3 Degree of Freedom Robotic Manipulator (R. Ramish, NED University of Engineering and Technology; Lvl:)	
	Isogeometric Analysis for More Accurate Simulation (M. Sederberg, Coreform LLC; Lvl: 2)	Emerging Vehicle Terrain Interaction Modeling & Simulation Techniques for High Fidelity Vehicle Dynamics (D. Simoni, Adaptive Corporation; Lvl: 2)	
4:55	CAASE18 Wrap-Up Presentation & Close (Grand Ballroom B) Presented by R. Dreisbach, NAFEMS Council and Chair of the Americas Steering Committee		

1 **2** **3**

Lvl: 1 = Introductory, 2 = Intermediate, 3 = Advanced

Huntington Convention Center Floor Plan



CAASE18 attendees will have three options for entering into the Huntingont Convention Center. If you are:

…staying at the Marriott, Westin, or Drury, use the Global Center for Health Innovation Entrance (1 St. Clair Ave NE).

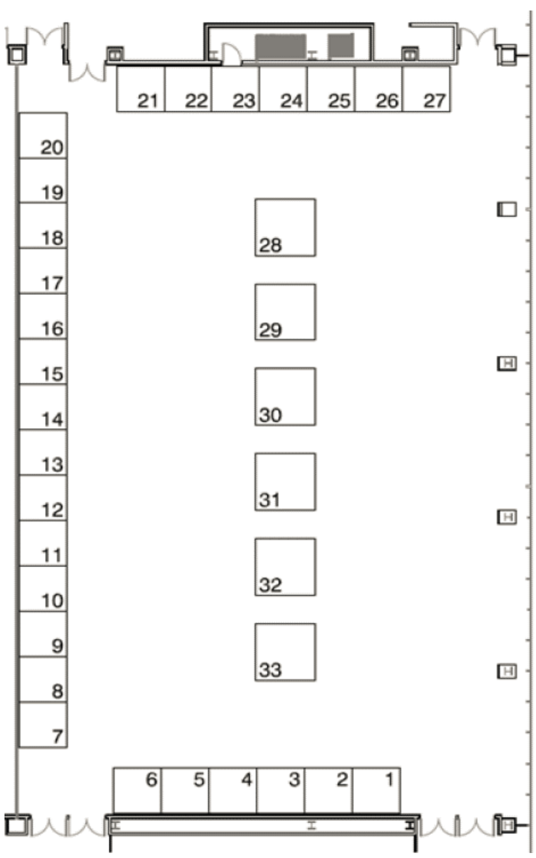
…staying at the Hilton or parking at Huntington Park Garage, use the Hilton Connector.

...parking at the Willard Garage, use the Huntington Convention Center of Cleveland Entrance (300 Lakeside Ave E)

Note: CAASE18 signage will be visible inside of the HCCC at all three entrances.

Exhibitor Hall (Grand Ballroom C)

1. Sigmetrix
2. Kinetic Vision
3. Penguin Computing
4. Synopsys
5. OSU SimCenter
6. TotalCAE
7. SmartUQ
8. HBM Prenscia
9. MultiMechanics
10. Rocky
11. COMSOL
12. ESTECO
13. Volume Graphics
14. BETA Simulation Solutions
15. Rescale
16. Math2Market
17. Recurdyn
18. Vcollab
19. Endurica
20. Adaptive Corporation
21. WolfStar Technologies
22. Ceetron
23. PWRS
24. ASME
25. DPS
26. INTES
27. AVL
28. Dassault Systèmes SIMULIA
29. Front End Analytics
30. MSC Software
31. Altair Engineering
32. Siemens PLM Software
33. ANSYS



Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Dynamic FEA (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Dynamic FEA

Session #: 1-1

Room #: 20

Abstract:

Based on the highly successful Basic and Advanced Dynamic FE Analysis e-learning courses, this combined short course will examine the breaking down of the dynamic problem into clearly defined steps.

Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Fatigue & Fracture Mechanics in FEA (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Fatigue & Fracture Mechanics in FEA

Session #: 1-2

Room #: 20

Abstract:

The objective of this course is to break down the fatigue analysis process into clearly defined steps, give an overview of the physics involved and show how to successfully implement practical solutions using Finite Element Analysis.

Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Composite FEA (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Composite FEA

Session #: 1-3

Room #: 20

Abstract:

Due to the nature of the composite, the stress components can include many more terms than a conventional metallic material, for example. Whatever the nature of the challenge, the objective of this course is to break down the composite analysis process into clearly defined steps, give an overview of the physics involved and show how to successfully implement practical solutions using Finite Element Analysis

Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Practical Modeling of Joints & Connections (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Practical Modeling of Joints & Connections

Session #: 2-3

Room #: 20

Abstract:

Most structures involve some form of jointing or connection.Traditional fabricated structures have used many thousands of bolts and rivets to connect components together in a continuous manner; in the case of ships and aircraft, the total can run into millions. The objective of this course is to review the various connection and joint technologies in use and give an overview of the physics involved and show how to successfully implement practical solutions.

Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Nonlinear FEA (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Nonlinear FEA

Session #: 3-2

Room #: 20

Abstract:

Many problems facing designers and engineers are nonlinear in nature. The response of a structure cannot be simply assessed using linear assumptions. Nonlinear behavior can take many forms and can be bewildering to the newcomer. All physical systems in the real world are inherently nonlinear in nature.One of the most difficult tasks facing an engineer is to decide whether a nonlinear analysis is really needed and if so what degree of nonlinearity should be applied. This short-course will examine these issues, and look at the best ways of dealing with these problems.

Presenter Name: Abbey, Tony

Presenter Company: FETraining

Presentation Title: NAFEMS Training: Structural Optimization (T. Abbey, FETraining; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Structural Optimization

Session #: 3-3

Room #: 20

Abstract:

This short over-view course is a condensed version of the standard NAFEMS training course on the topic. The objective of this course is to show you a broad overview of the range of FEA based tools available and what the methods and specializations of each encompass. Plentiful hints and tips will demonstrate powerful ways to use these methods. The goal is to achieve meaningful structural optimization in support of the most effective products.

Presenter Name: Abdi, Frank

Presenter Company: AlphaSTAR Corporation

Presentation Title: In-situ Monitoring and Thermal Calculation of 3D Print Process (F. Abdi, AlphaSTAR Corporation; Lvl: 2)

Type: Presentation

Keywords: 3D Print Manufacturing Process, In-Situ Monitoring, IR Thermal Camera, Big Data Processing, Heat Affected Zone meltpool, Micro-terrain Modeling and mapping, Part Quality, Thermal properties

Session Title: Additive Manufacturing Process Analysis 1

Session #: 1-1

Room #: 25B

Abstract:

Adequate quality inspection of finished parts is challenging and non-destructive techniques (NDT) are often difficult to realize. In-situ monitoring of 3D-print process takes advantage of the benefits of Big Data Processing (powder to part) to perform Real Time Visualization (RTM) of the AM process. "Micro-terrain Modeling and Mapping" is used to perform: RTM data processing visualization of Heat Affected Zone (HAZ) using Thermal-Viz Thermograph scanned camera data. The system translates and transforms thermal camera scanned data into high-level assessment of pixel/voxel quality. The Zeroth-Order Model (ZOM) thermal model is developed to provide fast numerical calculation of material performance including: (i) heat absorption from laser irradiation of the powder, (ii) powder melting, (iii) solidification, and (iv) and solidified melt and consideration of chemical reaction, grain growth, material phase-change shrinkage. The ZOM is integrated with the methodology, to utilize and process the HAZ regions and to predict temperature dependent mechanical properties through-the-thickness versus time. A general form of the heat transfer equation is developed that predicts the distributed temperature history. In real time, this algorithm calculates: 1) heating to melting temperature when laser is on; 2) melting when laser is on, including melt superheat (and melt cool down when laser is off); 3) solidification and 4) cooling of solid when laser is off. For 1 and 4, transient temperature gradients are secured with the assistance of the Finite Difference Explicit Method (FDEM), whereas in 2 and 3 the nodal temperature is constant with conduction through neighboring elements. The ZOM allows for incorporating the effect of defects on part quality; optimizing the critical parameters (temperature, speed of printing, scan pattern, etc.) with sensitivities, optimization, and performance of As-built/As-is part during manufacturing and under service-loading. Verification and validation will be performed for the HAZ and meltpool againt the FE 3D thermal model, and Dynamic X-Ray test measurements.

Presenter Name: Abusomwan, Uyiosa

Presenter Company: Schlumberger

Presentation Title: Model-Driven Engineering & Virtual Validation: Towards Design for Digital Twin (U. Abusomwan, Schlumberger; Lvl: 2)

Type: Presentation

Keywords: Simulation-Driven Engineering, Model-Driven Engineering, Digital Twin, Oil & Gas, Subsea Systems, Scrum Sprint, New Product Development

Session Title: Simulation Governance: Verification & Validation 1

Session #: 3-2

Room #: 24

Abstract:

The need to develop robust, safe and highly reliable Subsea systems that exceed stringent industry standards, coupled by the demand for High Pressure and High Temperature solutions, inspired the adaptation of model-driven engineering and virtual validation strategy in the design of next-generation Subsea valves. The presentation will provide an overview of the implementation of structural and functional analysis and simulation from the concept phase through the validation phase of the project. The talk will present a case study highlighting (i) the strategy for successful implementation of model-driven engineering in the management of New Product Development projects; (ii) the application of finite element analysis and simulation for solving complex design problems, evaluating the functionality of conceptual designs, and for optimizing the performance of new products during the design phase; (iii) the significant impact of model-driven engineering on project timeline and cost; (iv) the benefits and limitations of using engineering simulation for product validation; and (v) the future of model-driven engineering as an enabler in the implementation of Digital Twin technology. About the Authors: Dr. Uyiosa Abusomwan* (Mechanical Engineer), Schlumberger Mr. Laurent Alteirac (Project Manager), Schlumberger Uyiosa Abusomwan joined Schlumberger in 2014 as a Mechanical Engineer in the Testing & Subsea Product Group in Rosharon, TX. Since joining Schlumberger, he has worked with a New Product Development team focused on the design of next-generation HPHT subsea test tree systems. Prior to joining Schlumberger, Uyiosa worked as a mechanical engineer in the Reliability & Technical Support team at Joy Mining Machinery, and as an undergraduate researcher in the Intelligent Systems Division of the National Institute of Standards & Technology. He received a BS in Mechanical Engineering from New Jersey Institute of Technology, and a MS and PhD in Mechanical Engineering from Carnegie Mellon University. His doctoral research was in the area of contact mechanics and adhesion modeling of bio-inspired materials. *Speaker

Presenter Name: Actis, Ricardo

Presenter Company: ESRD, Inc.

Presentation Title: The Role of Simulation Governance in the Democratization of Simulation through the Use of Smart Sim Apps (R. Actis, ESRD, Inc.; Lvl: 3)

Type: Presentation

Keywords: Simulation governance, democratization of simulation, engineering simulation apps

Session Title: Simulation Governance: Collaboration 1

Session #: 1-1

Room #: 24

Abstract:

The technical and business value of numerical simulation performed by engineers across many industries, including those in the aviation, aerospace, and defense sector, is well established. However, the performance requirements and complexity of the products that engineers in these industries design has dramatically increased. This has created additional demands on the engineering organization to improve the speed, accuracy, and reliability of the simulation function. Incremental improvements to legacy finite element methodologies and software tools based upon them, are reaching a point of diminishing return as they struggle to address these new business challenges. All of this is occurring at the same time that the capabilities and complexity of these traditional FEA-based tools require ever greater levels of expertise and specialization from the engineering staff. Simulation Governance, a concept that originated from the appreciation that numerical simulation is a highly complex activity, is essential to address these challenges. A continuous investment in the training and management of simulation professionals, tools, and processes with numerous interdependent multi-disciplinary competencies is required. As the value on the simulation function increases, the practice of simulation governance, that is the command and control over simulation activities, becomes critical for ensuring the reliability and robustness of analysis methods and tools used in support of engineering decision-making processes. Simulation tools properly managed can be a major corporate asset, while when they are poorly managed can be a source of systemic risk. As example, for many valid reasons, finite element analysis software is regarded as so specialized that only expertly trained analysts can employ it with any degree of reliability and confidence in the results. Attempts to promote the use of FEA by general design engineers without expert training have been disappointing for equally valid reasons. There has been much discussion about the democratization of simulation, but is it feasible in industries like A&D, industrial equipment, medical device, or automotive? The admirable vision for expanding the use of simulation by non-experts cannot be safely realized unless a new approach to analysis based on predictive computational science and numerical simulation emerges to replace the art of finite element modeling as it has been practiced up to now. The solution lies in the practice of Simulation Governance which provides safeguards to ensure that the most difficult computational problems can be solved by experts with confidence, while more routine analysis in support of design decisions can be performed by engineers without expert training. To illustrate that a level of democratization is not only theoretically possible but readily feasible, examples from the aerospace industry of expert-designed smart simulation apps in the area of analysis of laminates composites and durability and damage tolerance analysis will be presented. The technical requirements and challenges to the creation, deployment, and use of Sim Apps will be examined without advocacy of any commercial software product or solution provider. The standardization, automation, and democratization of new technologies such as Sim Apps through the adherence to the practice of Simulation Governance offers many benefits to industry at the engineering, product, and business levels. These benefits include encapsulating complexity, improving productivity, containing cost, and ensuring reliability for the expert simulation analyst and non-expert design engineer alike.

Presenter Name: Aldred, Jon

Presenter Company: HBM Prenscia nCode

Presentation Title: Enabling Democratization By Engineers, For Engineers (J. Aldred, HBM Prenscia nCode; Lvl: 1)

Type: Presentation

Keywords: democratization, web-based CAE, data management, process management

Session Title: Democratization 3

Session #: 2-1

Room #: 23

Abstract:

There is increasing recognition of the value of democratizing the use of engineering software into the hands of more users. The vision for achieving this next step in the use of CAE tools has many aspects and projected benefits. Companies want to enable more engineers to be able to perform sophisticated simulations. This requires easy to use apps that help engineers solve a specific problem. The use of apps captures and transfers corporate knowledge, reduces the reliance on key individuals, increases the productivity of more engineers, improves quality and reduces errors. It increases the ability for the non-expert to perform analysis tasks that traditionally only experts have done. Democratization of engineering analysis drives greater value from the investment in software by expanding the number of engineers who are able to get reliable results. Experts, in turn, are freed up to spend more time on innovative and higher level projects. This vision however can be extended further beyond CAE to also include the integration of analysis of physical test and real-world sensor data. And if these apps are available through a web interface then no local software even needs to be installed. The challenge for engineering companies is how to do this without costly, internally driven developments that are difficult to maintain and extend. It is also necessary that these apps can be easily created by engineers themselves and do not require software development skills and custom IT projects. This vision of a “democratized” way of engineering requires the ability to put the power to democratize directly into the hands of engineers. This presentation describes capabilities required to make democratization a reality. For engineering apps to be viable, they must be easily created to target a specific type of task, leading users through the process in an easy-to-use web interface that hides the complexity of general purpose analysis tools. Engineers with sufficient engineering expertise but little programming experience should be be able to build these apps using simple drag and drop building blocks. This means the logical steps of the app and the layout of its graphical interface can be defined by the engineer without any coding. A central location is required to store and find these easy-to-use applications. Apps can be shared with individuals or groups to control user access but still with the flexibility to enable global collaboration. Built-in version control ensures engineers across the organization, whether in test laboratories, validation groups or design departments can always access the latest and correct version. Results from apps should be able to be shared with users in a secure manner improving the traceability and efficiency of communicating key information. The results from these analyses are stored together with all the inputs and settings so that previously calculated results can be quickly and directly accessed.

Presenter Name: Allu, Pareekshith

Presenter Company: Flow Science Inc.

Presentation Title: Simulations of Melt Pool Dynamics in Laser Powder Fusion Processes (P. Allu, Flow Science Inc.; Lvl: 2)

Type: Presentation

Keywords: CFD, additive manufacturing, powder bed fusion, simulations, modeling, laser welding

Session Title: Simulation of Manufacturing Methodologies & Processes: Welding

Session #: 1-3

Room #: 25C

Abstract:

Laser welding has been replacing traditional welding methods due to its superior productivity, faster scan speeds and lower heat inputs. With better control and smaller heat affected zones, laser processing technology has led to a rise of interest in metal additive manufacturing (AM) processes such as laser powder bed fusion and direct metal deposition. Although AM has been generating significant interest, challenges remain towards a more widespread adoption of this technology. These challenges include defect formation such as porosity and spatially non-uniform material properties that occur because of insufficient knowledge of process control. Computational fluid dynamics (CFD) modelling can help researchers understand the effects of process parameters on underlying physical phenomena such as melt pool dynamics, phase change and solidification. With experimental studies successfully capturing melt pool data such as molten metal velocities and temperatures, it is possible to calibrate numerical models using experimental data. These numerical models, which are based on a rigorous solution of the conservation equations, can provide further insights such as fluid convection in the melt pool, temperature gradients and solidification rates. In this presentation, case studies from industry and academia highlighting the use of CFD and numerical models in understanding powder bed fusion processes are discussed. Process parameter optimization in controlling porosity formation and balling defects for the IN718 alloy are studied in detail. On the one hand, slower laser scan speeds and higher angles of inclination in welding can lead to an unstable keyhole configuration, which typically results in porosity. On the other hand, faster scan speeds result in longer melt pools, and Rayleigh instabilities can cause the elongated melt pool to break down into tiny islands of molten metal resulting in balling defects. Depending on the process, it is critical to choose appropriate scan speeds. Additionally, the effects of powder packing density, laser power and particle size distribution on the formation of balling defects are explored. Finally, melt pool data from the numerical models is used to study and predict the solidification morphology for the IN718 alloy. Based on temperature gradients and solidification rates, which can be obtained through CFD models, it is possible to determine the resulting microstructure evolution and primary dendrite arm spacing resulting from the powder bed fusion processes. These results are compared to experimental data wherever available. These high fidelity, multiphysics CFD models provide a framework to better understand AM processes from the particle and melt pool scales. Using this information, it will be possible to more accurately model additional aspects of AM processes such as thermal and residual stresses and distortions in the entire part build.

Presenter Name: Anaya, Julio

Presenter Company: Mabe S.A. de C.V.

Presentation Title: Injection Molding Process Simulation during the Development of a Laundry Centre Tub (J. Anaya, Mabe S.A. de C.V.; Lvl: 1)

Type: Presentation

Keywords: Injection, Molding, Simulation, Rheological Properties, Correlation,

Session Title: Simulation of Manufacturing Methodologies & Processes 1

Session #: 3-1

Room #: 25B

Abstract:

New project considers renovating the current Laundry Centre platform for USA market in order to meet new international regulations. New tub is required, the tub is the bigger plastic component in a laundry centre, and it is a polypropylene homopolymer part with small thickness (2 – 3 mm). One of its mean functions are contain the mix of water and chemicals during the washer cycle and withstand inertial loads generated during spinning cycle, so as a component, it has to meet structural, performance, assembly and cost requirements, in addition, the clamping force capacity of injection machine that is available at facilities must not be exceeded. Learned lessons, as the use of rheological material characterization as a simulation input and a correlation of the finite element model with current process were applied in this new component development. Rheological properties of the polypropylene is shown, a better understanding of the material properties that affect the injection process was obtained. A good correlation of the finite element model with the current injection process was obtained also, then, after an iterative process, between structural and injection process simulation, where geometrical and process parameters changes were simulated, final design concept was achieve and released for tooling manufacturing. Then, at facilities, tubs were injected, in order to validate the design concept by a laundry centre prototypes building, machine clamping force limit was not exceeded and dimensional requirements were met, finally, a set of reliability test were completed without failures, so structural and performance requirement were accomplished too. As a result, an optimized tub design was completed. As a conclusion, in early development stages, injection process simulations allowed a quick and effective process for design concept iteration, additionally experimental work is important, material characterization and the finite element model correlation with the real process provides to the team with major certainty in the moment of design concept release.

Presenter Name: Anders, Markus

Presenter Company: Siemens Industry Software GmbH

Presentation Title: EV Drive-Cycle Performance: Optimization and Thermal Analysis (M. Anders, Siemens Industry Software GmbH; Lvl: 1)

Type: Presentation

Keywords: Electric machine, design, optimization, CFD, CHT, thermal analysis, e-powertrain

Session Title: Electrical 2

Session #: 1-2

Room #: 26C

Abstract:

On the demand of getting more power, higher torque alongside with higher efficiency and low cost the optimization and thermal analysis of an electrical machine design is coming to the fore more and more. With the latest changes mainly due to governmental restrictions or demands and directions the automotive industry is forced to undergo significant changes towards the electrification of the vehicles. This change in electrification is recognized in the aerospace and marine industry as well. The intended presentation is showing for a mid-sized EV traction motor the design process in using modern state-of the art design tools. The design process takes into account the optimization of the machine using HEEDS in conjunction with SPEED, not only on a single load point but for a full drive cycle. The objectives hereby are: minimizing the material cost and maximizing the averaged efficiency over the load cycle. As the maximum torque is mostly limited by the maximum winding temperature which is dependent on the selected insulation class, it is essential to predict the temperature and keep it below the limits of the corresponding insulation class which is also influencing the cost of the machine. The initial design of the machine and its required torque is done by using our SPEED™ software an analytical tool supported by electromagnetic 2D FE analysis. From those calculations we can derive the losses in the active material parts, such as copper, magnets and iron – which are itself temperature dependent. Additionally mechanical (bearings, windage and friction) losses can be analytical estimated. By coupling STAR-CCM+® and SPEED, both flow/thermal and electromagnetic aspects can be tackled in the same working environment, resulting in a better, optimized design process. The thermal analysis of electric motors is a complicated process because of the multiple heat transfer paths within the motor and the different materials and thermal interfaces through which the heat must pass to be removed. A full 3D CHT analysis takes all the different heat transfer path directly in the electrical machine and its applied cooling system into account. The thermal analysis is carried out again for the whole drive cycle. Finally a Co-Simulation approach which decouples the time-scales of the fluids and the solid parts in the CHT calculation speeds up the simulation time significantly.

Presenter Name: Andrews, Mark

Presenter Company: SmartUQ

Presentation Title: Introduction to Probabilistic Analysis and Uncertainty Quantification (M. Andrews, SmartUQ; Lvl: 1)

Type: Training

Keywords: Probabilistic Analysis, Uncertainty Quantification, Stochastics,Analytics,Design of Experiments,Gaussian Process,Model Calibration,Model Validation,Sensitivity Analysis, Simulation

Session Title: Introduction to Probabilistic Analysis and Uncertainty Quantification

Session #: 1-3

Room #: 21

Abstract:

Presenters: Mark Andrews, SmartUQ UQ Technology Steward, Madison, WI, USA. Peter Chien, Professor in Statistics, University of Wisconsin – Madison, Madison, WI, USA. SmartUQ Chief Scientist, Madison, WI, USA. Abstract: Uncertainty is an inescapable reality that can be found in nearly all types of engineering analyses. It arises from sources like measurement inaccuracies, material properties, boundary and initial conditions, and modeling approximations. Using case studies, this training course will introduce probabilistic and Uncertainty Quantification (UQ) methods, benefits, and tools. UQ is a systematic process that puts error bands on the results by incorporating real world variability and probabilistic behavior into engineering and systems analysis. UQ answers the question: what is likely to happen when the system is subjected to uncertain and variable inputs. Answering this question facilitates significant risk reduction, robust design, and greater confidence in engineering decisions. Modern UQ techniques use powerful statistical models to map the input-output relationships of the system, significantly reducing the number of simulations or tests required to get accurate answers. The course will discuss Gaussian processes, polynomial chaos expansion, sparse grids, Latin hypercube designs, model calibration, model validation, sensitivity analysis, and how to account for aleatoric and epistemic uncertainties. These probabilistic techniques are nearly universal and can be applied to all forms of engineering systems. The attendees for this course would be engineers, program managers, and data scientists who are familiar with probabilistic analytics and want to further investigate how Uncertainty Quantification can maximize insight, improve design, and reduce time and resources. This is purely an educational tutorial and will focus on the concepts, methods and applications of probabilistic analysis and uncertainty quantification. SmartUQ software will only be used for illustration of the methods and examples presented. Outline: • Introduction to UQ • Techniques o Design of Experiments - Sparse Grids - Latin Hypercube designs o Gaussian Process o Model Calibration o Model Validation o Sensitivity Analysis o Uncertainty Propagation o Polynomial Chaos Expansion • Benefits • Example Problems

Presenter Name: Andrews, Mark

Presenter Company: SmartUQ

Presentation Title: Uncertainty Quantification with Complex Data (M. Andrews, SmartUQ; Lvl: 2)

Type: Training

Keywords: Probabilistic Analysis,Uncertainty Quantification, Stochastics,Complex Data,Experimental Analyses,Surrogate Modeling,Emulators,Design of Experiments,Bayesian Calibration,Model Calibration,Model Validation,Uncertainty Propagation,Sensitivity Analysis,Simul

Session Title: Uncertainty Quantification with Complex Data

Session #: 2-1

Room #: 22

Abstract:

Presenters: Mark Andrews, UQ Technology Steward, SmartUQ, Madison, WI, USA. Peter Chien, Professor in Statistics, University of Wisconsin – Madison, Madison, WI, USA. Chief Scientist, SmartUQ, Madison, WI, USA. Abstract: Advancements in simulation software and high-performance computing have led to the possibility of new technologies like the Digital Twin which deliver a continuous stream of complex data from simulation models. However, analyses of these data streams using basic Uncertainty Quantification (UQ) methods does not always yield the results sought. The emergence of complex data from these technologies has spawned new analytic methods for extracting pertinent and meaningful information. This tutorial is an introduction to the new methods being used to quantify uncertainties for complex data sets. Complex data can be a combination of many things. It can have multiple responses including spatial-temporal functional response or be high-dimensional and require a large number of simulation runs to analyze. Complex data can involve a mixture of continuous and categorical inputs and outputs. The tutorial will discuss the many challenges of complex data, how these new methods are applied to them and the results they yield. The benefits of using the new methods are as follows: long runtimes for complex simulations can be greatly reduced through emulator or surrogate modeling techniques. The ability to build predictive surrogate models for either spatial or temporal responses are available with the ability to gain additional knowledge through sensitivity analysis and uncertainty propagation. Methods to merge simulations from different fidelities into a surrogate model are possible with the potential to save time and resources. Bayesian calibration can quantify model-form uncertainties between the simulation and tests. With these technologies, the challenges of the size and form of a complex data set can be resolved. This tutorial will focus on the background and methods of these technologies. The audience for this tutorial would be engineers and managers involved in or overseeing simulation design and analyses and experimental analyses. Attendees should leave with an understanding of how advanced UQ methods can improve their experimental design and testing, quantify the uncertainties in their simulations and validate their simulation results. This is purely an educational tutorial and will focus on the concepts, methods and applications of uncertainty quantification with complex data. SmartUQ software will only be used for illustration of the methods and examples presented. Outline: • Brief Background of UQ • Benefits of UQ • Complex Data Challenges • Emulators/Surrogate Modeling o Functional Emulator o Emulator with Spatial Response o Mixed Input Emulator o Multi-Fidelity Emulator o Gradient-enhanced Emulator • Advanced UQ Techniques o Bayesian Calibration • Tutorial Summary

Presenter Name: Andrews, Mark

Presenter Company: SmartUQ

Presentation Title: Catapulting Through Simulation Uncertainty with Model Calibration (M. Andrews, SmartUQ; Lvl: 2)

Type: Training

Keywords: Probabilistic Analysis,Uncertainty Quantification, Stochastics,Physical Experiments,Predictive Analysis,Surrogate Modeling,Design of Experiments,Model Calibration,Model Validation,Sensitivity Analysis,Simulation,Tests

Session Title: Catapulting Through Simulation Uncertainty with Model Calibration

Session #: 2-3

Room #: 22

Abstract:

Presenters: Mark Andrews, UQ Technology Steward, SmartUQ, Madison, WI, USA. Peter Chien, Professor in Statistics, University of Wisconsin – Madison, Madison, WI, USA. Chief Scientist, SmartUQ, Madison, WI, USA. Abstract: As simulation models increase in complexity, the importance of understanding the uncertainty in both the simulations and the physical experiments goes up significantly. However, using model calibration, it is possible to determine how close the simulation results are to reality and to quantify the uncertainty from the simulation model. This tutorial will use a live case study of a catapult to sequentially walk through the processes used to quantify uncertainties for simulations and physical experiments using model calibration. The tutorial will start with the development of two designs of experiments (DOEs); one for the simulation model and the other for the physical test. The simulation model will then be used to run its DOE prescribed points and the combination of the inputs and results will be used develop a surrogate model. The fidelity of the surrogate model will be determined by a comparison with the simulation and then used to conduct parameter sensitivity analysis and predict the uncertainty in the projectile distance based on model input variations. For the physical testing, members of the audience will use the physical DOE and collect a portion of the experimental data live by catapulting lightweight balls and measuring the horizontal distance traveled. Then the surrogate model will be calibrated and validated with the physical data. Finally, the tutorial will present a summary of the calibration exercise and quantify the benefits of the calibration process. The calibration procedure will be illustrated by using the SmartUQ software. The audience for this tutorial would be engineers and managers involved in or overseeing simulation design and analyses and experimental analyses. Attendees should leave with an understanding of how to apply calibration to their combined simulation and testing environments and to be able to understand the fundamental value that statistical calibration brings. This is purely an educational tutorial and will focus on the concepts, methods and applications of simulation model calibration. SmartUQ software will only be used for illustration of the methods and examples presented. Tutorial Outline: 1. Overview and learning objectives of the tutorial 2. Simulation a. Developing Design of Experiments for simulation b. Training the surrogate model and examining its fidelity c. Conducting parameter sensitivity analysis d. Propagating the model uncertainties e. Predicting the horizontal distance of the projectile 3. Physical Tests a. Developing Design of Experiments for experimental data b. Determining Measurement uncertainties c. Identifying calibration parameters d. Conducting the catapult experiments 4. Statistical Calibration 5. Calibration results 6. Tutorial summary and closing remarks

Presenter Name: Andrews, Mark

Presenter Company: SmartUQ

Presentation Title: Uncertainty Quantification with Missing Values (M. Andrews, SmartUQ; Lvl: 3)

Type: Presentation

Keywords: Uncertainty quantification, generalized polynomial chaos expansion, missing values, sparse grid, data augmentation, design of experiments, emulators

Session Title: Simulation Governance: Uncertainty Quantification

Session #: 3-1

Room #: 24

Abstract:

Uncertainty quantification (UQ) has emerged as the science of quantitative characterization and reduction of uncertainties in simulation and testing. Stretching across applied mathematics, statistics, and engineering, UQ is a multidisciplinary field with broad applications. A popular UQ method to analyse the effects of input variability and uncertainty on the system responses is generalized Polynomial Chaos Expansion (gPCE). This method was developed using applied mathematics and does not require knowledge of a simulation's physics. Thus, gPCE may be used across disparate industries and is applicable to both individual component and system level simulations. A shortcoming of gPCE is that the assumption that simulation results can be collected precisely on a set of carefully-chosen input configurations. Because of this assumption, gPCE encounters problems when any of the input configurations fail to produce valid simulation results. gPCE requires that results be collected on a sparse grid Design of Experiment (DOE), which is generated based on probability distributions of the input variables. A failure to run the simulation at any one input configuration can result in a large decrease in the accuracy of a gPCE. The decrease can necessitate the generation and simulation of an entirely new sparse grid input configuration. In practice, simulation data sets with missing values are common because simulations regularly yield invalid results due to physical restrictions or numerical instability. Such failures render existing UQ methods unreliable. Evaluation of new input configurations requires a great deal of time, risks further failures and wastes the original computational effort. We propose a statistical framework to mitigate the cost of missing values. This framework decreases the additional simulation runs necessary to yield accurate UQ results in the event that simulation failure makes gPCE methods unreliable. By careful data augmentation, the proposed framework can recycle existing simulation results when constructing a space filling DOE. The new simulation results from this space filling design can be used to fit robust statistical emulators. The process of choosing new points and fitting emulators has minimal computational overhead even for large data sets. Once fitted, the emulators may be used to perform a variety of UQ tasks in place of gPCE methods. These emulators may also be used for additional analytics tasks such as model calibration, design space exploration, and optimization. Several examples are used to demonstrate the proposed frame work and its utility including a simple beam deflection model and several non-linear test functions.

Presenter Name: Arnold, Steve

Presenter Company: NASA Glenn Research Center

Presentation Title: A 2040 Vision for Integrated, Multiscale Materials and System Modeling and Simulation (S. Arnold, NASA Glenn Research Center; Lvl: 1)

Type: Presentation

Keywords: ICME, computational materials, Measurement, Optimization, Data, Informatics, Workflow

Session Title: Multiscale

Session #: 1-1

Room #: 21

Abstract:

Over the last few decades, advances in high-performance computing, new materials characterization methods, and, more recently, an emphasis on integrated computational materials engineering (ICME) and additive manufacturing have been a catalyst for multiscale modeling and simulation-based design of materials and structures in the aerospace industry. While these advances have driven significant progress in the development of aerospace components and systems, that progress has been limited by persistent technology and infrastructure challenges that must be overcome to realize the full potential of integrated materials and systems design and simulation modeling throughout the supply chain. As a result, NASA's Transformational Tools and Technology (TTT) Project sponsored a study (performed by a diverse team led by Pratt & Whitney) to define the potential 25-year future state required for integrated multiscale modeling of materials and systems (e.g., load-bearing structures) to accelerate the pace and reduce the expense of innovation in future aerospace and aeronautical systems. This talk will describe the findings of this 2040 Vision study (e.g., the 2040 vision state; the required interdependent core technical work areas, Key Element (KE); identified gaps and actions to close those gaps; and major recommendations). This roadmap is a community consensus document and is a result of over 450 professionals input obtain via: i) four society workshops (AIAA, NAFEMS, and two TMS), ii) a community-wide survey, and iii) the establishment of 9 expert panels (one per KE) consisting on average of 10 non-team members from academia, government and industry to review, update content, and prioritize gaps and actions. The study envisions the development of a cyber-physical-social ecosystem comprised of experimentally verified and validated computational models, tools, and techniques, along with the associated digital tapestry, that impacts the entire supply chain to enable cost-effective, rapid, and revolutionary design of fit-for-purpose materials, components, and systems. Although the vision focused on aeronautics and space applications, it is believed that other engineering communities (e.g., automotive, biomedical, etc.) can benefit as well from the proposed framework with only minor modifications. Finally, it is TTT's hope and desire that this vision provides the strategic guidance to both public and private research and development decision makers to make the proposed 2040 vision state a reality and thereby provide a significant advancement in the United States global competitiveness.

Presenter Name: Aversa, Piero

Presenter Company: Ford Motor Company

Presentation Title: Providing the Transformational Means to a New Era of Sustainability and Mobility (P. Aversa, Ford Motor Company; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 1

Room #: Grand Ballroom B

Abstract:

The automotive engineering community is now confronting the largest technological transformation since its inception. Recent advancements related to the electrification of powertrains for more efficient consumption and cleaner emissions, the reinvention of the battery with fast wireless charging capabilities to fully replace the current fuel driven vehicles and finally the advent of fully autonomous vehicles. The car as we know it today will totally change! It will have a so-called “soul” and will be an extension of your personality which you can talk to, can read your face and lips, and would know your mood and feelings as it transports you from point A to point B. The whole concept of passenger transportation is being transformed into a Safer, Healthier and Smarter Environment. The challenges ahead for automotive engineers are enormous and SIMULATION will be playing a very important role in delivering these Smart Vehicles in a very demanding Smart World.

Presenter Name: Bauer, Constantin

Presenter Company: Math2Market GmbH

Presentation Title: Micromechanical Modeling and Simulation of a Multifunctional Hybrid Composite (C. Bauer, Math2Market GmbH; Lvl: 1)

Type: Presentation

Keywords: Micromechanical Simulation, Composite, Steel Fiber, Carbon Fiber, Hybrid Material

Session Title: Advanced Composites

Session #: 1-1

Room #: 25A

Abstract:

Due to their superior weight-specific mechanical properties, carbon fiber reinforced polymers (CFRP) are increasingly used in automotive industry. One of the main reasons is the compensation of the penalty weight caused by the components for the electrification of the passenger cars. However, the brittle failure behavior of CFRP limits its structural integrity and damage tolerance in case of impact and crash events. Furthermore, the electrical conductivity of CFRP structures is insufficient for certain applications. Former research attempts tried to resolve the mechanical and electrical deficits of CFRP by modifying the resin system (e.g. by addition of conductive particles or toughening agents), but could not prove sufficient enhancements. A novel approach is the incorporation of highly conductive and ductile continuous metal fibers into the CFRP. The basic idea of this hybrid material concept is to address both the electrical and load-bearing capabilities of the integrated metal fibers to improve the electrical conductivity and the failure behavior of the composite. To understand the complex interaction of carbon and metal fibers of a loaded hybrid composite, a micromechanical model of unidirectional and multiaxial laminates is build up using the structure generators of the software GeoDict. For each constituent material, separate user defined material models (UMAT) with individual failure criterions are developed and implemented to simulate the macroscopic material behavior. Through the modelling of the microscopic structure and damages the strength of the laminate could be determined using the GeoDict module ElastoDict. This module uses a solver called FeelMath which is developed at the Fraunhofer Institute for Industrial Mathematics. This fast and memory efficient solver is capable to handle the huge number of elements required for such accurate micromechanical simulations. Additionally, the electrical conductivity of the different laminates is simulated using the GeoDict module ConductoDict. The numerical study is validated with experimental test results on unidirectional and multiaxial specimens with different steel-carbon-fiber-ratios. The simulation results are in a good accordance with the experimental data and give additionally a detailed insight in the micromechanics of this complex hybrid composite material.

Presenter Name: Bauer, Constantin

Presenter Company: Math2Market GmbH

Presentation Title: Material Simulation Based on Micro-Computed Tomography Data (C. Bauer, Math2Market GmbH; Lvl: 1)

Type: Workshop

Keywords: Composites, Microstructure, Mechanics, X-Ray, Tomography, GeoDict, Short Fiber

Session Title: Material Simulation Based on Micro-Computed Tomography Data

Session #: 2-2

Room #: 21

Abstract:

Composite materials are crucial in current component development to improve the functionality and lightweight design. Assessing the material behavior of composites by experimental determination is highly complex due to their inhomogeneity and the interplay of anisotropy and differences in stiffness of the single material components. In this workshop the mechanical material properties of a short fiber reinforced polymer will be determined using the software GeoDict. Therefore a material sample scanned by micro-computed tomography is imported and segmented into the different constituent materials, here fiber and matrix. Afterwards the homogenized material properties are calculated using the imported microstructure and the properties of the fiber and the matrix material. After the simulation, the stress distribution inside the structure can be visualized and the inhomogeneity of the material becomes clear. For the simulation a solver called FeelMath is used which is developed at the Fraunhofer Institute for Industrial Mathematics, ITWM. The solver is based on the fast Fourier transform (FFT) to solve an integral equation and overcomes the barriers of the conventional methods using low memory and shorter processing times. The calculation on realistic three-dimensional microstructure models is accelerated to several orders of magnitude while maintaining accuracy. This fast and memory efficient solver allows a simulation of a microstructure based on more than 15,000,000 voxel elements in about 45 seconds on a standard laptop. In the next step of the workshop, the orientation and the geometry of the fibers inside the scanned material sample is analyzed. The obtained data are used to generate an equivalent model of the microstructure. Afterwards the mechanical properties are calculated again. On the basis of the generated model a small parameter study will be performed to determine the sensitivity of the macroscopic material properties to the geometric characteristics of the microstructure. The goal of the workshop is to show the simulation engineer that microstructural material simulation is a very powerful tool to understand the behavior of the investigated material. The simulation can provide insights into the interactions of the different constituent materials that an experiment is not able to give. The first step of a material improvement is the understanding of the material.

Presenter Name: Betts, Juan

Presenter Company: Front End Analytics LLC

Presentation Title: A Business Centric Approach to Simulation Democratization (J. Betts, Front End Analytics LLC; Lvl:)

Type: Presentation

Keywords: simulation democratization, systems engineering, process automation

Session Title: Democratization 4

Session #: 2-2

Room #: 23

Abstract:

This paper describes structured four-stage process for the development and deployment of a business centric, platform neutral approach risk-balanced approach to simulation democratization currently being employed by major OEM in the discrete manufacturing space. Below are some of the steps of this approach: 1. OEM's Business Drivers were aligned and linked to Simulation Democratization: Links between the OEM's Business Drivers (revenue/cost), Machine Systems and Engineering Domains were established to focus Simulation Democratization efforts on areas that would have the greatest impact to the OEM. 2. The OEM's "As Is" Simulation Democratization Maturity State was Assessed: Detailed discussions were performed with various leaders from the different Machine Systems to assess their functional areas Simulation Democratization Maturity. Current simulation democratization projects were evaluated against two criteria. The first criterion was Critical Success Factors (CSF), which are factors that successful simulation democratization initiatives have had in common in industry. Some of these factors include: (1) Having senior management support, (2) understanding that there are multiple approaches to democratization (not just buying some vendor's platform), etc. The second criterion was evaluating these initiatives against established Simulation Democratization Principles (SPDs). Some of these SPDs include: Having solutions that speak the language of the intended user, anticipating user mistakes, etc. This resulted in the "As Is" state of Simulation Democratization Maturity at the OEM. 3. Simulation Democratization Strategies to Close Gap were Determined: A Risk vs. Return platform agnostic portfolio framework for strategies for Simulation Democratization was presented to the team leaders. These strategies from lower risk/lower reward to higher risk / higher reward included: (1) Improving Current Tools Robustness & Usability, (2) Developing a Virtual Engineering Toolbox (VET), (3) Creating CAD Embedded Solutions and (4) Automating Simulation Processes through SPDM and Developing Faster Solving Methods. More detailed discussions with Machine Systems leaders led to the identification of key demonstrator pilot project that would move the needle in increasing the OEM's Simulation Democratization Maturity and close the gap identified in the "As Is" state. 4. Simulation Democratization Pilot Projects to Close Gap were Proposed and Implemented: Pilot Demonstrator Simulation Democratization Project Charters were written and aligned with the specific needs of Machine Systems business objectives. These demonstrator projects used Simulation Democratization "Best Practices" and addressed resources, risks, timelines and alignment with key stakeholders from the OEM's Machine Systems.

Presenter Name: Bogomolny, Michael

Presenter Company: ParaMatters Inc

Presentation Title: Cognitive Generative Design (M. Bogomolny, ParaMatters Inc; Lvl: 1)

Type: Presentation

Keywords: topology optimization, generative design, computational geometry, HPC, computational design, Lattice Structures, Meta-Materials, Porous Structures, Lightweight Design

Session Title: Product Design Based on Additive Manufacturing 2

Session #: 2-2

Room #: 25B

Abstract:

Cognitive systems are quickly becoming an important part of our lives, from smartphones to self-driving cars just to name a few. The idea behind these systems is to relieve us from tedious routine tasks in order to give more time for creative and enjoyable work. However, in CAD we are still in the age of manual labor, where the user is solely responsible for defining the shape of the design components. Afterwards, the created design is usually validated using CAE tools. If the design does not perform well under the applied loads, it needs to be modified and the process is repeated again until all requirements are met. This iterative process can take weeks to complete, it requires many valuable man-hours and most importantly, it does not guarantee optimal results. ParaMatters Inc. is developing CogniCAD in order to help engineers to achieve optimal designs. The technology is built upon state-of-the-art topology optimization, computational geometry algorithms, HPC and cloud computing. Most recent developments in the fields of generative design and digital manufacturing are about to change the way we create new things. Automatic design optimization allows generating extremely efficient structures and meta-materials for a wide range of engineering applications, while Additive Manufacturing (AM) transforms these digital designs into real products. The technology developed by ParaMatters allows automatic generation of superior designs for direct Additive Manufacturing, considering static deformation, stresses and vibration modes, within tens of minutes up to several hours. In this presentation, a unique cognitive cloud-based generative design platform which compiles lightweight structures and meta-materials (lattices) by demand, as well as simplifies and shortens the design-to-additive manufacturing process, will be presented. The following three topics will be covered: a. How to generate optimal topology designs for Additive Manufacturing. b. How to generate meta-materials (lattices) with desired properties and performance. c. How to generate optimal meso-structural designs, which combine general topology and meta-materials for energy absorption and fail-safe applications.

Presenter Name: Brayford, Paul

Presenter Company: Syncroness

Presentation Title: Computational Analysis of Components Produced by Fused Deposition Modeling, and the Importance of Print Orientation (P. Brayford, Syncroness; Lvl: 1)

Type: Presentation

Keywords: FDM, analysis, print orientation, ASTM, D638, D3039, ULTEM, isotropic, anisotropic, orthotropic

Session Title: Product Design Based on Additive Manufacturing 1

Session #: 2-1

Room #: 25B

Abstract:

In the whitepaper this presentation will be based on, we examine the nature of material properties in FDM components and the difficulties in applying rigorous analysis. We also construct a demonstrative component to examine the comparative effects of the manufacturing build orientation variable on mechanical response. Given the observation that infill bond strength plays a significant role in the bulk tensile strength of printed components, we theorize that there is additional material behavior that the direct application of ASTM D638 does not capture. For this discussion, we assume a component with a simple rectangular layer. If we print a rectangular block using rectangular layers that have the same width as the XZ samples, we would expect it to behave with the same properties as the XZ data when loaded in the same tensile direction as the samples. Similarly, we would expect a block printed with layers as wide as the XY samples to follow the response of the XY data. However, given that the percentage of infill is the primary contributor to the variance of as-printed material properties, if we print a rectangular block with rectangular layers that have a width between the XZ and XY samples, we know that the infill percentage will be between 50% and 88% as driven by the block width, and that the material properties of this in-between layer width should fall between the XZ and XY data. It follows that as the layer width is only defined by component geometry, and can be anything from a single nozzle diameter up to the maximum dimension the printer can produce, there exist differing material property datasets below, in-between, and above, the captured XY and XZ data. We assert that the material data collected from the XY and XZ samples represent only two discrete points along a continuous curve; layer width vs. material performance. This curve describes a material that is geometry-dependent anisotropic, with material properties that vary not only with the direction the load is applied but also with the size of the feature that the load is applied to. Thorough characterization of such a material would be difficult but could theoretically produce a curve for each varying material property against layer width. For simulation comparisons, this study focused on three build orientations, based on which side of the part was parallel to the print bed. Provided the use of support material to allow high-angle overhangs is acceptable, it is possible to print the part in any orientation within the build volume of an FDM printer. If we assume that one of the flat sides of the component must lie on the print bed, we could rotate the component about the vertical axis and generate a curve relating the angle of rotation to the minimum FOS. The maximum point on this curve would indicate the most advantageous rotation angle at which to print the component, potentially further improving the minimum FOS in loading. Theoretically, this approach could be extended to multiple orientations and curves if there are a few sides of the component particularly suited to be aligned with the print bed, or out to any orientation if the part does not have any obvious side to place on the print bed. While it might be possible to manually iterate or use an iterative simulation tool such as SolidWorks Optimization for a known set of orientations and rotation axes, more advanced software with robust optimization algorithms would be required to optimally place a component at any orientation in the build volume.

Presenter Name: Buijk, Arjaan

Presenter Company: Simufact-Americas LLC

Presentation Title: Managing Metal AM Process Variability Through FEA Based Testing and Controls (A. Buijk, Simufact-Americas LLC; Lvl: 1)

Type: Presentation

Keywords:

Session Title: Product Design Based on Additive Manufacturing 2

Session #: 2-2

Room #: 25B

Abstract:

Metal AM part qualification is difficult and subject to significant variability in the process. This variability is driven by many factors and not easily understood or quantified. Users of metal AM machines understand that there is a natural “drift” in the process that leads to change in the resulting build. NASA recently released technical standards (MSFC-SPEC-3716 and MSFC-SPEC-3717) that specify the need to calibrate machines regularly and instructions on how to do so. These documents also specify that any observed non-conformance requires that all parts built after the last calibration must be quarantined and verified to determine if they are defective or not. It is logical to assume that AM build process drift is not always or even frequently discontinuous step function but rather a more linear, continuous change that happens over time. This change can be related to the optics, laser, inert gas, and many other factors. This work describes a proposed method to quantify process drift, monitor it over time, and establish limits to the drift that are tied to the required dimensional control and stress state of parts. The approach described will leverage a printed test artifact coupled with finite element analysis process simulation software to routinely quantify the residual stress and strain imparted by the AM build process and evaluate the effects on resulting builds. This method can enable users to take preventative actions to correct the process drift before it results in scrap and quality spillage resulting from non-conforming parts. Ultimately, this approach may enable the successful deployment of metal AM around the world. This would be made possible by facilitating a quick setup and calibration of different machines in different locations so that each was able to successfully build the same part despite varying conditions.

Presenter Name: Calisto da Silva, Jose Carlos

Presenter Company: STV Inc.

Presentation Title: Nonlinear Fracture Mechanics Applications in Bridge Design (J. Calisto da Silva, STV Inc.; Lvl:)

Type: Presentation

Keywords: non-linear, fracture mechanics, bridge, design, global analysis, detail analysis, conclusions, recommendations

Session Title: Nonlinear

Session #: 2-1

Room #: 25C

Abstract:

Structural Analysis -Linear & Nonlinear Static & Dynamic Common practice bridge design is to use linear elastic analyses to determine the design internal forces of a structure, or the resultant stresses in the same. However, there are situations that go beyond the elastic limit of behavior of structures, such as seismic events, or the inherent non-linear behavior of some elements in the structure, when a linear elastic analysis is not enough. The matter complicated further for the case of reinforced concrete, which is a composition of two materials, one of brittle behavior - concrete - and other of a ductile behavior - the reinforcing steel. Therefore, for this case is not enough to specify a simple elastic-plastic behavior model, since the reinforced concrete "material" has a more complex behavior that depends on the amount of smeared (distributed) steel and the presence of concentrated steel, with a strong difference according to the direction considered in relation to the orientation of the reinforcement. Some of these case came about when doing a non-linear pushover, or seismic analysis to determine the parameters for performance-based design of a reinforced concrete structure, without having to use empirical, or semi-empirical methods to define the formation of plastic hinges within the structure. Other situations have come about, also under seismic conditions, where there were elements of the structure with distributed reinforcement mixed with high concentrations of bundled bars, where cracking and estimation of damage were essential to be determined. Lastly, there were situations involving the possible use of bearings without maintenances, such as the case of Freyssinet type bearings, or of steel bearings embedded in the reinforced concrete, where in addition to the highly non-linear behavior, involving concrete cracking, there was also the susceptibility to concrete fatigue, which is a not very common occurrence. For all those cases it was needed to have an analysis based on the fracture mechanics approach, which has proven to be a good choice and that yielded very conclusive results.

Presenter Name: Casagranda, Al

Presenter Company: Idaho National Laboratory

Presentation Title: MOOSE Framework Overview and BISON Application Demonstration (A. Casagranda, Idaho National Laboratory; Lvl: 2)

Type: Presentation

Keywords: MOOSE, BISON

Session Title: Multiphysics 2

Session #: 3-1

Room #: 21

Abstract:

The Multiphysics Object Oriented Simulation Environment (MOOSE) is an open-source framework developed at Idaho National Laboratory (INL) to facilitate solving complex real-world engineering problems. Scientists and engineers have used MOOSE to create applications for simulating nuclear fuel performance (BISON), microstructure evolution (MARMOT), material degradation and aging (GRIZZLY) and other coupled nonlinear phenomenon. The MOOSE framework provides a significant set of capabilities to applications including robust solver technology, support for massively parallel execution, modular code development, extensive documentation, continuous integration and regression testing as well as user support. This presentation will provide the background for the development of the MOOSE framework and an overview of several primary applications. The development of MOOSE began in 2008 at INL primarily to support nuclear energy modeling efforts. Since that time numerous MOOSE-based applications in diverse areas of science and engineering have been created by developers from many different countries. The release of MOOSE on GitHub in 2014 under the GNU LGPL 2.1 license enabled developers from around the world to more easily contribute to the software and interact with the MOOSE team. The BISON nuclear fuel performance code will be used as an example of leveraging the capabilities of the MOOSE framework and to demonstrate the benefits obtained. Nuclear fuel experiences a complex set of multiphysics phenomena during operation in a reactor. These phenomena occur over distances from nanometers to meters and time scales from microseconds to years. In order to model the coupled physics involved in this application would normally require a large software development effort. However, the BISON team utilizes the basic physics implemented in MOOSE, such as solid mechanics, heat transfer, mechanical and thermal contact, and thus can focus on nuclear-specific materials and processes. This highly reduces the development workload for BISON. In addition, the inherent parallel support provided by MOOSE allows large simulations to be run efficiently on Linux-based clusters. A recent BISON model of a missing pellet surface problem will be used to illustrate these advantages. Finally, the impact of MOOSE-based tools in industrial applications will be demonstrated by BISON through the Consortium for Advanced Simulation of Light Water Reactors (CASL). CASL was created in 2010 by the US Department of Energy (DOE) as an innovation hub focused on advancing commercial nuclear power. A primary goal is the development of a virtual environment to simulate a nuclear reactor. The Virtual Environment for Reactor Applications (VERA) has been created and used to accurately simulate the operating history of the Watts Bar Unit 1 nuclear reactor. VERA was also used to model the startup of Watts Bar Unit 2 and continues to provide predictions for supporting future refueling operations.

Presenter Name: Castro, Jack

Presenter Company: The Boeing Company

Presentation Title: LOTAR EAS and International Standards and How It Relates to Advancing Analysis and Simulation in Engineering (J. Castro, The Boeing Company; Lvl:)

Type: Presentation

Keywords: LOTAR, ISO, STEP, AP209, engineering, analysis, simulation

Session Title: Emerging Standards

Session #: 2-1

Room #: 26C

Abstract:

The LOTAR International Engineering Analysis and Simulation Working Group (EAS WG) continues its ongoing efforts to communicate with users and software developers about progress towards supporting the need for LOTAR and management of engineering analysis and simulation data. There are two themes at CAASE18 with topics that are relevant to a discussion of LOTAR of EAS data (modeled on the Open Archival Information System - OAIS), efforts to encourage development of commercial off-the-shelf (COTS) ISO STEP AP209 ed2 translators and establish best practices for LOTAR and data management. The actions of the LOTAR EAS WG relate to topics and sub-topics within Theme #2 “Implementing Simulation Governance & Democratization” as they pertain to LOTAR of EAS data and ISO STEP AP209 translators. Standards for data interchange facilitate the planning of CAE strategy and tactics as part of a simulation governance policy. In addition, it lays the groundwork for collaboration between all disciplines that are engaged in the lifecycle of product development, especially in the context of the “digital thread” that connects them as a system of systems. This connectivity facilitates many benefits of using well-defined data models to capture input, context and results such as: process and knowledge capture, verification and validation; quality assurance; integration; data management; etc. It also breaks down barriers to the democratization of analysis and simulation. If sufficient effort is expended to: define analysis and simulation methods to model the physics; input is collected from the best available and appropriate sources; the validity of this collection is verified; and the pedigree of these data are preserved, the resulting outcome facilitates sharing, learning and advancing computer-aided analysis and simulation. The second theme that the LOTAR EAS WG and related work are aligned with is Theme #4 “Addressing Business Strategies & Challenges.” With well-managed methods, input and results from engineering analysis and simulation comes the ability to manage a valuable resource to assist decision making in support of business strategies. With facts and data, it becomes possible to quantify the benefit of using computer-aided analysis and simulation. A product that demonstrates superior performance at a marketable cost, that was predicted in advance, using reliable and repeatable processes that can be continuously improved, can change a company’s ability to compete in the global economy. Facts and data can defeat fear and ignorance that evolve in business cultures after previous attempts at automating or standardizing processes have failed. An open and transparent “digital thread” can unlock potential, moderate risk and improve the bottom line. If that “digital thread” is built on a system of non-proprietary data interchange standards, the ability to migrate or morph a company’s culture of product development and lifecycle management to fit new and improved processes. Removing barriers to change can make us nimble and able to adapt. The case will be made that LOTAR of EAS data, use of international standards for data interchange for analysis and simulation data and laying the groundwork for their use in science and engineering will aid in advancing the use of computer-aided analysis and simulation. 1. References CCSDS 650.0-M-2, “Reference Model for an Open Archival Information System (OAIS), Recommended Practice, Issue 2,” June 2012 ISO 10303-209:2014, “Industrial automation systems and integration -- Product data representation and exchange -- Part 209: Application protocol: Multidisciplinary analysis and design,” December 2014

Presenter Name: Chakraborty, Arindam

Presenter Company: VIAS

Presentation Title: Additive Manufacturing Process Simulation and Generative Design – Production of Functional Parts (A. Chakraborty, VIAS; Lvl: 1)

Type: Presentation

Keywords: additive manufacturing, generative design, abaqus

Session Title: Product Design Based on Additive Manufacturing 3

Session #: 2-3

Room #: 25B

Abstract:

Additive manufacturing (AM) or 3D printing is maturing rapidly as a viable solution of make optimized parts for "real engineering" applications. What started as an amateurish persuasion has now evolved into a worldwide phenomenon that is touching industries from aerospace to industrial equipment to automotive to life science to energy & process, and others. The freedom of design that is achievable using AM process is un parallel in terms of reducing structural weight, reducing material cost, generating complex shapes and connections and introducing directional properties in a component. However, understanding of AM process and utilizing process parameters to optimize a design comes with many challenges. Currently, one of the emphasize is to use physics based realistic simulation to replicate the AM process numerically and relate process parameters to the concept of functional generative design that relates design with manufacturing process. Current work, through a typical build example, discusses an integrated numerical solution on a digital platform that involves the following. Generative Design involving topology optimization that creates parts in context of the manufacturing process and automatically generate variants of conceptual and detailed organic shapes that helps make informed business decisions based on physics-based analytic tools. Process planning that defines and customizes manufacturing environment including nesting parts automatically on the build tray, designing and generating optimal support structures, and creating machine specific slicing and scan path which is ready for print. Process simulation that automatically includes machine inputs for energy, material and supports into the simulation at layer, part and build levels for any additive manufacturing process and accurately predicts part distortions, residual stresses and as-built material behavior. Finally, the platform involves post processing to perform shape optimization where simulation is used to guide support-structure strategy for enhanced build yield, compensate distortion effects without the need to redesign the product tooling, produce high-quality morphed surface geometry with unchanged topology, and perform final in-service performance validations of manufactured part.

Presenter Name: Chakraborty, Arindam

Presenter Company: VIAS

Presentation Title: Design Optimization of Safety Critical Component for Fatigue and Strength Using Simulation and Data Analytics (A. Chakraborty, VIAS; Lvl: 2)

Type: Presentation

Keywords: DESIGN OPTIMIZATION, FATIGUE, FEA, ISIGHT, FE-SAFE, ABAQUS, DATA ANALYTICS

Session Title: Optimization 2

Session #: 3-1

Room #: 26A

Abstract:

The current work focuses on simulation based optimization of a complex, safety critical component where it is prohibitively expensive to carry out finite element analysis (FEA) simulations for all possible sample realizations and therefore requires statistical or machine learning techniques for a timely yet accurate solution. The applicability of machine learning further brings the opportunity of performing in-service monitoring using sensor data and thereby performing predictive maintenance. A deterministic design optimization of Blowout Preventer (BOP) for operation in high pressure subsea environment is performed with the objective of maximizing the fatigue life of the equipment while reducing the weight and displacement at a critical location. BOPs are mechanical devices designed to seal off wellbore, safely control and monitor oil and gas well in case of blowout. The optimization process requires exploration of the design space, creating response surface functions to represent the complex input-output relationship, and running the optimization algorithm based to response surface model. The process requires many sample evaluations and therefore, a workflow automating is done using Simulia portfolio software Isight that performs parametric optimization and automation. The design input parameters with their respective realistic lower and upper bounds are defined to study the design space. Based on input-output data traditional methods for response surface generation are used. A separate algorithm based on the principles of machine learning is also used to generate the response surface function using the design space exploration matrix of input-output variables & parameters. Machine learning can help in design simulations by generating predictive models to estimate output given initial parameters. The output of a simulation is approximated using deep network architectures for regression. This approach generally requires less sampling of design space compared to traditional methods such as radial basis function, krigging, etc. This framework can be included within the Isight environment easily which may reduce the overall burden of individual FEA runs.

Presenter Name: Chang, Hanson

Presenter Company: MSC Software

Presentation Title: Large Assembly Modeling Using Glued Contact (H. Chang, MSC Software; Lvl: 2)

Type: Presentation

Keywords: large assembly modeling, connections, glued contact, flexible glued contact, connectivity validation, segment-to-segment contact, beam contact, fastened joints, bonded joints, fastened joint flexibility, load distribution

Session Title: Contact, Joints, Welds & Connections 1

Session #: 1-1

Room #: 25C

Abstract:

Finite element models often include multiple parts that are challenging or time consuming to weave into an integrated, sound, numerically valid model. The parts may require different mesh densities, or may not line up in a way that is convenient to achieve an integral mesh. And quite often, the model is an assembly of separate models, possibly created by different analysts. The task of connecting the different parts together and ensuring there are no unwanted "cracks" in the model is a challenge, especially in large assembly models with tens or hundreds of parts. Glued contact is a technique used by structural analysts to meet this challenge. "Glue" is a term used to describe setting up a model so that parts act as though they are bonded together. Glued contact (aka tied contact) uses multi-point constraints to tie parts together. Glued contact can be used to model fastened connections (bolts, rivets, shear pins, etc.) or actual bonded connections. Glued contact is fast and easy to setup because mesh congruency is not required. This paper will present several recent advancements in glued contact which enable the structural analyst to more efficiently and accurately build these large assembly models. The segment-to-segment glued contact method in MSC Nastran will be presented. This method allows cross-sections of beams and shell edge faces to be available for gluing, making it much easier to assemble an idealized "stick & panel" loads model. This method also allows the structural analyst to add joint flexibility to glued connections, achieving more accurate stiffness representation and load distribution in the assembly model. An aircraft wing assembly model will be used to demonstrate the effects of flexible glued contact on normal modes and load distribution. When adding joint flexibility to a glued connection, the analyst can specify stiffness values in the tangential and normal directions. This paper will use a simple airframe splice joint example to demonstrate how to convert fastened joint stiffness values into glued contact stiffness values. The resulting load distribution inside the glued joint will be compared with results from a model using discrete fastener representations.

Presenter Name: Cole, Linda

Presenter Company: Open iT

Presentation Title: How to Make the Most of Your Analysis and Simulation Applications (L. Cole, Open iT; Lvl: 2)

Type: Presentation

Keywords: optimizing software licenses, software usage metering, software usage metering tools, optimizing software applications, optimizing software usage, software optimization

Session Title: ROI for Simulation Investment

Session #: 3-1

Room #: 25A

Abstract:

Applications for engineering are evolving at an accelerated pace. They provide more and more capabilities, supporting digitization from concept to delivery. For that they are capturing a larger share of investments within the company and, because of that, they are demanding better management systems to monitor and meter their actual usage. These more capable applications will also have an impact on the IT infrastructure. The engineering industry has advanced with the use of analysis and simulation software. Engineering companies can optimize the entire design, prototype, test and production of bringing a new product to market with these software applications. Access to the latest and most innovative software tools is sometimes difficult due to the overwhelming costs of these packages. In today's session, we will not focus on optimizing designs but more specifically, optimizing the software licenses to enable: reduced software costs, identifying unused software to free up budget to be spent on new apps and features, understanding cost allocation by actual usage by department or project and understanding usage for vendor negotiations. The best way to achieve optimization of your expensive licenses is through usage metering tools. Software usage tools measure how much and how often applications are used and allow managers to quickly and easily analyze true needs. Some usage metering tools also go further by not only providing historical data but by simulating various types of agreements and scenarios to help managers make more informed decisions. This presentation will provide real engineering customer data, report examples as well as case studies where usage metering saved significant money. Business and IT Managers are applying usage data to optimize their resources and save their companies real dollars while creating a competitive edge. Whether you're managing analysis or other simulation applications, usage metering allows you to provide the right software to the right person at the right time thereby optimizing your costs.

Presenter Name: Combier, Robert

Presenter Company: Rescale

Presentation Title: Cloud HPC Demystified: Best Practices of Executing and Managing Simulation Workloads on the Cloud (R. Combier, Rescale; Lvl: 2)

Type: Workshop

Keywords: cloud, hpc, simulation on the cloud, cloud bursting, burst computing, rescale, collaboration, data management, scalability, automation, cloud security,

Session Title: Cloud HPC Demystified: Best Practices of Executing and Managing Simulation Workloads on the Cloud

Session #: 3-1

Room #: 25C

Abstract:

High performance computing on the cloud offers a variety of advantages to simulation engineers and teams, notably instantly scalable computing architecture, broad software access, and integrated automation tools. However, transitioning these simulation workflows directly to the cloud can be exceedingly complex to first time users and their IT organizations. They can be difficult to monitor, manage and control-- and more importantly they can be challenging to perform securely. This 90 minute workshop will cover how to easily overcome these challenges and convey other cloud fundamental concepts (beyond just bursting) in a short presentation. Some common questions engineers may face when considering cloud computing are “Which of my workflows are most suitable for cloud computing?”, “How do I address file size or file count issues with the cloud?”, and "How do I connect to my license server or manage on-demand license models?" The presentation portion will address identifying workflow suitability, the best practices for transitioning to the cloud, and then conclude with a live end-to-end workflow on the Rescale ScaleX platform. Following the workflow demonstration example, there will be a short discussion session in small groups where key barriers and questions can be addressed and shared with the rest of the participants. In addition to addressing the transition of simulation workflows to the cloud, attendees should also exit the workshop with a grasp of how overall data management is treated in the cloud. This includes strategies for uploading and retrieving large files and data, sets how data is stored and organized between different cloud data mechanisms, and the relevant security measures for data in transit and at rest. The workshop will also cover touch on relevant cloud administration functions, such as how job monitoring is handled, how jobs are shared within teams, and how software and on-demand licensing can be supported.

Presenter Name: Comstock, Krista

Presenter Company: Procter & Gamble

Presentation Title: Integrating Simulation into Requirements & System Engineering Work Processes (K. Comstock, Procter & Gamble; Lvl:)

Type: Presentation

Keywords: Simulation Process & Data Management, SPDM, Deomcratization, MBSE, Concurrent Innovation, Systems Engineering

Session Title: Simulation Governance: Process Management

Session #: 1-3

Room #: 24

Abstract:

"Procter & Gamble is focused on building consumer-preferred brands and products that create value for consumers and shareowners. Everything begins with consumer understanding and winning at the zero moment of truth when consumers search for our brands, at the first moment of truth when they choose our brands, and at the second moment of truth when they use our products. Winning these moments of truth leads to consumer purchase, preference, regular usage and long-term loyalty. This is how we create value for consumers, build leadership brands and businesses, and create value for P&G share owners. Modeling and Simulation is a key enabler for driving Procter & Gamble's superior brands and products. Modeling & Simulation has "grown up" within the development processes. Before, modeling may have provided direction into a final physical experiment which would be documented and used for a decision. Today, simulation is becoming how we learn, as well as that final test from which key decisions are made. P&G also has a strategy to democratize simulation to non-experts through simplified interfaces and apps. Singularly, these systems have been very costly to create and maintain. A scalable solution is required to make this goal attainable. Any solution for P&G must consider our wide breath of simulation disciplines and global footprint of users and experts. The ability to retrieve and reuse our models requires a federated solution. As simulation becomes the way we learn, it must be integrated effectively into our innovation work processes. The first is a need that the data be retained and documented in similar ways to how physical methods have been captured for reproducibility. Secondly, is a question of where and how to most affectively apply our simulations which has driven work in Systems Engineering and Requirements Driven Learning Plans (Model Based Design). We have chosen Dassault 3DExperience's V+R Process Applications to be our Simulation system of record as well as deployment framework. As this begins to deploy, we are also investigating how to best integrate that functionality with both the Requirements management capability within the 3DExperience platform as well as separate Systems Engineering management tools. Depending on the business situation both solutions are perceived to bring business value and therefore are in pilots within P&G. As the MBSE capabilities are still maturing, we are developing the needed technical solutions to meet these goals. This presentation will focus on the journey P&G is traveling, with the successes and challenges along that road."

Presenter Name: Croegaert, Mike

Presenter Company: Mentor Graphics Corporation

Presentation Title: Optimizing the Design of Liquid Cooled Avionics System through the Use of Characterized 3D CFD Simulations in a 1D System Simulation (M. Croegaert, Mentor Graphics Corporation; Lvl: 2)

Type: Presentation

Keywords: CFD, Avionics, System Simulation

Session Title: Systems Simulation 2

Session #: 2-3

Room #: 26C

Abstract:

Modern military aircraft platforms are using more and more power which results in an ever increasing power density (SWaP). This in turn, generates more heat that has to be dissipated from the instrument panel and cockpit of the aircraft. Complicating this further is that the use of structural composites which are not efficient conductors of heat and the mission requirements of small heat signatures. Therefore alternative means of extracting the heat from the avionics systems must be used. Liquid cooled systems have the advantage over air cooled systems of a much higher heat transfer rate and the fact that the heat can be transported a significant distance from the source. While the idea of liquid cooled avionics is not new, they have gained significant more attention with the latest generation of military aircraft as the only viable method of cooling the systems while maintaining the operational specs of the aircraft. Liquid cooled avionics have their own challenges as well. The architecture of the components (cold plates, etc) used for extracting the heat from the electronics component must be optimized to perform consistently and reliably while maintaining the smallest footprint possible in the already crowded instrument panel. Additionally, these systems require piping, pumps, valves, heat exchangers and controls as well as a heat sink to send the heat to. In most military applications this is the fuel. Therefore, the design engineers must consider not only the design of the avionics package with its cooling requirements but also what to do with the heat once it has been transferred to the coolant. This requires the ability to optimize both the component design with the cooling design concurrently. A proposed method for this concurrent optimization is through the use of characterized 3D CFD simulations from a CAD imbedded CFD software in a system simulation tool using model based design approach. This allows initial evaluations of the cooling system long before the physical components would be available for bench testing.

Presenter Name: Crompton, Jeff

Presenter Company: AltaSim Technologies LLC

Presentation Title: Simulation of Atmospheric Air Plasma (J. Crompton, AltaSim Technologies LLC; Lvl:)

Type: Presentation

Keywords: Plasma, chemical reactions, turbulent flow, heat transfer.

Session Title: Multiphysics 4

Session #: 3-3

Room #: 21

Abstract:

Decontamination of sensitive surfaces and sterilization of living tissue using traditional high temperature or chemical surface treatment methods may destroy the required functionality of the surface. For these surfaces, small-scale cold plasma jets produced in atmospheric air can provide an alternative by using regions of highly reactive chemistry that are near room temperature. Plasmas are inherently multiphysics phenomena, and feature a tightly coupled system of electromagnetics, fluid flow, physical kinetics, chemical reactions and heat transfer, as such any attempt to develop the technology using traditional testing and evaluation methods is inherently unstable. Computational simulation can be used to help design plasma devices and operating conditions that optimize the effectiveness of cold plasma jets, however due to the strong coupling that occurs between the electric field, fluid flow, physical kinetics, chemical reactions, and heat transfer, the simulation of plasma jets is a challenging multiphysics problem. In this work, air at atmospheric pressure flows through a hollow anode and cathode. Prior to exiting the device, the air is subjected to a strong electric field that results in the development of a plasma jet at the nozzle exit. The small diameter of the plasma and the turbulent heat transfer in the flow lead to the development of a plasma jet that is sustained at a low temperature, while the reactive species that are developed in the plasma continue to exist some distance away from the nozzle. In the current work, a fully coupled analysis of an air plasma jet has been performed using COMSOL Multiphysics®. The non-equilibrium, non-Maxwellian plasma is modelled using a fluid approximation that solves for the transport of the electron density and the mean electron energy, and the two-term Boltzmann equation is used to calculate the transport coefficients and electron impact reaction rate coefficients. The plasma chemistry includes 19 species and 183 reactions, and transport equations are solved for each species. To solve for the momentum transport of the bulk fluid, the k-? turbulence model is used. The plasma, species transport, and fluid flow equations are coupled to together and to a heat transfer equation for conduction and convection, including the effect of turbulent flow. The simulation results have been used to predict the temperature distribution and the concentrations of reactive species within the jet.

Presenter Name: Denlinger, Erik

Presenter Company: Autodesk

Presentation Title: Simulating Laser Powder Bed Fusion Processes Using the Multiscale Method (E. Denlinger, Autodesk; Lvl: 2)

Type: Presentation

Keywords: laser powder bed fusion, nonlinear finite element methods, multi-scale modeling, distortion, support structure failure, recoater blade interference

Session Title: Simulation of Manufacturing Methodologies & Processes 1

Session #: 3-1

Room #: 25B

Abstract:

A primary challenge for Laser Powder Bed Fusion (LPBF) to become a reliable and economically feasible method of component production is the warping of parts during production. This distortion adds expense of the process, can take weeks or months of experimentation to minimize, and may prematurely end the businesses case for implementing AM into production. Multi-scale modeling can predict and mitigate build failure prior to manufacture. This study shows through simulation-experimental comparisons that this approach can be used to make timely and useful predictions of distortion for common AM metals. It will also document the successful modeling of the secondary failure mechanisms of support structure delamination and recoater blade interference. Simulation based distortion mitigation will be demonstrated by simulating a part and compensating the build geometry to reduce deformation. Finally, the concept of multi-scale modeling will be extended to the prediction of hot-spots and lack of fusion related defects on Part-Level AM builds.

Presenter Name: Dewhurst, Sebastian

Presenter Company: EASA Software

Presentation Title: Excel is an Engineering Application, Too! The Challenges and Opportunities of Spreadsheets in Engineering (S. Dewhurst, EASA Software; Lvl: 2)

Type: Presentation

Keywords: Excel, spreadsheet, governance, version control, deployment

Session Title: Simulation Governance: Collaboration 2

Session #: 1-2

Room #: 24

Abstract:

This paper discusses the results of a recent NAFEMS survey which shows that despite huge advances in CAD, CAE and PLM tools, spreadsheets remain widely used in engineering and manufacturing. The reasons are well-known: Excel is flexible, easy to use, and powerful, and as such is a valuable tool for not only preliminary design and engineering calculations, but also for activities such as Engineering-to-Order, Configuration, Pricing and Quoting (CPQ), as well as ad hoc data repositories. Other key findings of the survey include: • More than 80% of respondents indicate that the usage of Excel within their respective organizations is either increasing or staying the same. Only 12% indicate usage is declining. In other words, spreadsheets are here to stay. • The vast majority of respondents use a critical spreadsheet daily or weekly. Only 22% use critical spreadsheets infrequently; more than 20% use a critical spreadsheet many times a day. ("Critical" was defined as implying an error could have a significant negative impact on the organization). • The life expectancy of most critical spreadsheets is more than 1 year; more than 35% are expected to "live" more than 5 years. • The use of spreadsheets is NOT being discouraged; in fact, nearly 30% said that they are specifically encouraged. • Nearly 25% of respondents indicated that the lack of spreadsheet governance had caused regulatory or compliance issues, while more than 75% indicated they have no formal process associated with spreadsheet use. • Spreadsheets are shared – a lot – and sharing is a major cause of compliance issues. • The vast majority of spreadsheets are shared via network drives or email, with little or no version control, authentication, or security of intellectual property. An overwhelming majority of respondents indicated that it would help if a recognized organization such as NAFEMS defined best practices and general guidelines for spreadsheet authoring, approval, and sharing. Finally, this paper will also present a summary of several technologies that are being used to successfully mitigate some of the issues highlighted above. These include SharePoint, EASA, and ClusterSeven.

Presenter Name: Dewhurst, Sebastian

Presenter Company: EASA Software

Presentation Title: An Investigation into the Suitability of Machine Learning Methodologies As a Supplement to Conventional Engineering Analysis (S. Dewhurst, EASA Software; Lvl: 2)

Type: Presentation

Keywords: machine learning, democratization, process automation

Session Title: Simulation Governance: Process Management

Session #: 1-3

Room #: 24

Abstract:

Historically, engineers have relied heavily on experimentation in order to make useful predictions about the performance of their designs. This has produced many significant advancements of technology. A well-known example is the Wright Brothers' use of a home-made wind-tunnel to measure the lift and drag characteristics of various airfoils, directly leading to the first successful heavier-than-air flight in 1903. Analytical methods have also been useful, but until the advent of modern computers they were usually limited to relatively simple cases, such as laminar flow down an axisymmetric pipe, or deflection of a beam with a regular cross-section. However, now that adequate computing power is almost a commodity, problems with more complex boundary conditions and geometries can now be solved, and a multitude of commercial packages are available for this purpose. While modern engineering analysis tools have dramatically improved our ability to model many problems, which in turn has enabled us to reduce or eliminate experimentation, there remain some problems which do not lend themselves to conventional analytical methods. Examples include prediction of fatigue failures, lamination failures, quality "drift" in a production line, and (returning to the original example of airfoils) the accurate prediction of critical angle of attack. Machine learning is a relatively new approach which has been applied to a wide variety of computing tasks where designing and programming explicit algorithms with acceptable accuracy and performance is either difficult or impossible. Machine learning models allow researchers, scientists, engineers, and analysts to generate reliable and repeatable predictions through learning from historical trends in (usually a large quantity of) experimental data. This paper discusses the application of the various open-source machine learning tools to problems of engineering significance. Tools investigated include TensorFlow™, an open-source software library developed originally for internal use at Google, and also Scikit-learn (formerly scikits.learn), a free software machine learning library for the Python programming language. As a complement to this research, the authors have also applied a commercially available low-code development platform (EASA). This type of technology, also known as "hpaPaaS" – High Productivity Application Platform as a Service – enables "citizen developers" or "authors" to "appify" and democratize "expert-only" software tools and models. It enables non-programmers to codelessly create custom, fit-for-purpose apps, complete with error trapping and design or business rules embedded. Previous work has highlighted the value of this approach in leveraging models created with Excel, MATLAB, R, or commercial codes. However, the current work demonstrates the feasibility and convenience of extending this approach to deploy models based on machine learning, which would otherwise remain usable only by computer scientists.

Presenter Name: D'Souza, Karl

Presenter Company: Dassault Systèmes SIMULIA Corp

Presentation Title: Personalized Cardiovascular Modeling for Medical Device Efficacy, Drug Safety, and Clinical Guidance (K. D'Souza, Dassault Systèmes SIMULIA Corp; Lvl:)

Type: Presentation

Keywords: personalized healthcare, digital health, cardiovascular, modeling, simulation, patient care, virtual human, drug safety, multiscale modeling

Session Title: Medical Devices 2

Session #: 2-3

Room #: 26B

Abstract:

The Living Heart Project was launched in 2014 to advance the use of computational modeling and simulation for the diagnosis and treatment of cardiovascular disease, and to translate the technological innovations generated by the Project into improved patient care today. The Living Heart Model (LHM), an anatomically and physiologically realistic 3D model of an adult human heart was released as a commercial product by Dassault Systemes in 2015 and is now available on the 3DEXPERIENCE platform on the cloud. In this paper, we describe how this technology is enabling the use of personalized cardiovascular modeling for medical device efficacy, drug safety, and surgical guidance. The LHM can be modified to recapitulate a known disease state in two complementary ways. In some case, patient-specific image data may be available that can be used to determine the region of the heart that is affected. Alternatively, the parameters governing cardiac electrical or mechanical behavior can be adjusted such that the modified model is able to reproduce patient-specific clinical metrics. Having represented the underlying disease state, device makers can then simulate the interaction of a new device with the diseased heart, thereby gaining actionable insight on the influence of the heart on the device and vice versa. Moreover, to account for real world variability, rather than using a single diseased heart model, multiple diseased models can be generated that collectively represent the target patient population. This methodology can be used to further optimize the device design, or to produce multiple designs each of which is best suited to a subset of the target patient group. We discuss the feasibility and value of such virtual patient trials in the design, testing, and deployment of medical devices. Cardiac arrhythmia can be an undesirable and potentially lethal side effect of drug action on the human body. Before is new drug is approved, pharmaceutical companies must assess the risk of arrhythmia posed by the drug. Currently, this process is time-consuming and expensive because early stage safety assessment protocols are unable to accurately predict the effect of a drug on real 3D hearts. The LHM now provides a foundation upon which virtual safety studies can be conducted that can reduce the time and cost of animal and human experimentation while also providing mechanistic insight into drug action at the cellular and whole organ levels. To enable this new functionality, computational models of single cardiac cells capable of modeling the dynamics of individual ion channels are coupled with whole heart tissue models to simulate how drug-induced changes at the cellular level affect macroscopic electrical behavior at the whole heart level. We show how multiscale cardiac modeling can be used simulate the onset and propagation of drug-induced arrhythmia. Congenital heart defects are the leading cause of birth-defect related deaths. The first two years of life are crucial for a child's vascular development, so early surgical restoration of blood circulation is critical when newborns are diagnosed with cardiac anatomical malformations. However, congenital heart defects often involve uncommon or even unique cardiac anatomies - this means that clinicians must rely almost entirely on their own intuition for critical surgical decisions, and congenital interventions today often result in poor patient outcomes. The methods used to construct the LHM are now being used to address this problem. Modeling tools on the 3DEXPERIENCE platform can be used to replicate real surgical procedures, and detailed blood flow simulations can identify the treatment option that most improves the child's circulation. As these tools mature, we can expect patient-specific modeling and simulation to be increasingly integrated into the regular practice of health care for children as well as adults.

Presenter Name: D'Souza, Karl

Presenter Company: Dassault Systèmes SIMULIA Corp

Presentation Title: Blood Flow Modeling in a Beating Human Heart with Applications in Medical Device Design and Patient Care (K. D'Souza, Dassault Systèmes SIMULIA Corp; Lvl:)

Type: Presentation

Keywords: CFD, simulation, patient care, medical devices, blood flow, cardiovascular, personalized health, precision medicine

Session Title: Medical Devices 3

Session #: 3-1

Room #: 26B

Abstract:

Cardiovascular disease remains the leading cause of death in developed countries and continues to drive billions of dollars in R&D aimed at improving devices, diagnosis and treatment. Since the introduction of stents in the 1980s death rates have dropped, yet those gains have since plateaued, signaling the need for a new generation of treatments that are safer, more effective and minimize unintended complications. To achieve this goal, it is critical to return the body as functionally close to its original state as possible, accounting for both the physical device-body interactions as well as the physiological changes in heart motion, electrical conduction and blood flow. Cardiac motion can affect device stability and performance while the presence of the device can alter the motion in return. Over the long term, these changes as well as modified blood flow patterns may lead to structural remodeling that can have adverse on cardiovascular function that can sometimes prove fatal. Computational tools are uniquely capable of accounting for cardiac/vascular tissue mechanics, blood flow, and the interaction between them, yet are currently under-utilized due to their complexity. Moreover, such tools must allow for inter-patient variation and provide meaningful visualization capabilities to support clinical decision-making. The Living Heart Model (LHM), an anatomically and physiologically realistic 3D model of a human heart represents a breakthrough in providing a platform for such analyses. In this paper, we focus on the LHM for 3D blood flow modeling to better understand the human heart in both healthy and diseased states as well as to improve the efficacy of cardiovascular medical devices and to guide the clinical treatment of heart disease. Applications of blood flow modeling today are numerous, encompassing a wide variety of conceptual and technical approaches. These range from 1D lumped parameter models (LPMs) of the cardiovascular system to highly detailed 3D fluid-structure interaction (FSI) simulations. Each has a place in modeling the function of a medical device; 3D models provide high resolution quantitative and visual information on device-body interactions inside a beating human heart, while LPMs provide real-time insight on cardiac behavior and are ideally suited for equally important applications where spatial resolution is less critical, such as exploring the cardiovascular parameter space to identify disease conditions. We begin by showing how such low-fidelity LPMs have been used to introduce disease-specific or patient-specific characteristics in the LHM following which detailed 3D device-heart simulations can be conducted. Next, we discuss the use of various 3D flow modeling techniques to assess the efficacy of medical devices. Special focus is given to valvular diseases where small hemodynamic changes can have large consequences. Traditional continuum-based (Navier-Stokes) CFD tools can provide highly accurate fluid pressures and wall shear stresses but may pose practical barriers in situations involving complex geometries and pinched flow. Particle-based (e.g., Lattice-Boltzmann) CFD tools overcome these limitations but be problematic when complex boundary conditions and FSI are required. We analyze cases using both approaches and discuss best practices in the context of the problem being modeled and the level of accuracy desired. We conclude with two applications of blood flow modeling to guide surgical intervention. In the first application, we explore the likelihood of rupture of patient-specific abdominal aortic and carotid aneurysms. In the second application, we discuss the importance of blood flow modeling in the surgical treatment of Hypoplastic Left Heart Syndrome (HLHS), a common congenital heart defect in newborns that requires immediate intervention to restore normal circulation. These examples place simulation in the context of real-world clinical workflows, involving modeling the surgical procedure as well as selecting of the optimal intervention based on 3D patient-specific blood flow modeling.

Presenter Name: Du, Wenbo

Presenter Company: Siemens PLM Software

Presentation Title: Fast Charging – An Attractive Option for EVs Owners with Range Anxiety (W. Du, Siemens PLM Software; Lvl: 2)

Type: Presentation

Keywords: Fast charge,Lithium ion,Battery,EV,HEV,Temperature,Cell design

Session Title: Electrical 1

Session #: 1-1

Room #: 26C

Abstract:

The automotive industry is undergoing a significant mutation with the development of autonomous driving and powertrain electrification. The latter is becoming more common on the market and projections show a constant increase of these vehicles in the future. However it is not a rapid take over from conventional cars as their price tag is still an impediment to their large adoption by consumers, even if incentives exist in many countries. Nevertheless they present many advantages such as little to no tailpipe emissions. Another reason for their slow expansion is the rather low drive range these vehicles offer. The longest range available on the market is 300km in real driving conditions. Although this would be sufficient for the usual daily commute from home to office, people have the feeling this is not enough for the few times a year they have to drive 500 km (over 310 miles). This is known as range anxiety. This means that for this type of journey one would have to stop at the service to recharge the batteries. And this may take a while. Alternatively, one could benefit from a fast charge station, where it is claimed the battery can be charged up to 50% of its full capacity in 20 min. However fast charge can be harmful to the battery if not controlled and managed correctly. Indeed fast charging a battery implies using a high current charge which has several effects on the battery. On the first hand it generates a lot of heat, which increases the battery temperature. In this case it is critical for safety matters that the temperature remains below 45 oC. Above, the temperature could lead to reactions which could damage the battery or set the all vehicle on fire. Secondly, the high current can lead to dendrite formation. Lithium metal is deposited on the anode electrode surface and grows slowly towards the cathode. At the point where the dendrite is in contact with the cathode, a short circuit occurs. It damages the cell, but also could lead to hazardous situation, which again could lead to set the vehicle on fire. This presentation introduces a new way of designing Li-ion battery cells, by using numerical modeling, to understand and predict how a cell behaves under fast charge conditions. We introduce how the Li-ion battery cell design and performance modelling is carried out using the software Battery Design Studio, and we present a study in which simulations of a cell in various fast charge conditions are performed. We look at the effect of the ambient temperature but also the variation current applied for fast charge. It is then possible to analyze the Li-ion cell temperature rise and estimate if dendrites are growing on the surface of the anode. After problems with fast charge have been identified, the study suggest solutions to these problems by applying design changes to the cell components. A design exploration study is carried out to vary the different design parameters which would ensure that the cell charging capacity is maximized in 20 min. However this is only valid if the temperature safety limit is never reached and no dendrites are growing. This study presents a valid design and is compared to the original one used in the first part of the presentation. This presentation was also used in a blog news on our website at the following address for more details: https://community.plm.automation.siemens.com/t5/Cd-Adapco-Blog/Fast-Charging-an-imperative-option-for-EVs/ba-p/434302

Presenter Name: Eckblad, Zack

Presenter Company: Eckdyn Analysis Solutions

Presentation Title: Taming the Wild Beast: Encapsulating Open-Source Software behind Democratization Framework (Z. Eckblad, Eckdyn Analysis Solutions; Lvl: 1)

Type: Presentation

Keywords: Automation, simulation, design space study, FEA plug and play, integrated system analysis, democratization, automation, Simulation Apps, FEA, finite element, cae, cad, Simulation Automation, CAD CAE Integration, Non-Experts Accessing Simulation, meta-code

Session Title: Democratization 2

Session #: 1-2

Room #: 23

Abstract:

Open source simulation software is pervasively available in many diverse forms and platforms. It has been used for both simple and complex analysis tasks. Further, in-house software and morphs on open source software are frequently developed to meet organizational objectives or reduce costs of analysis. While open source and custom codes have areas of strength, this is frequently offset by significantly missing functionality which detracts from being able to adopt a specific open source code to cover the full range of problems encountered in an industrial setting. Further, full-featured pre-and post-processing can be difficult or non-existent in the form needed for a given project or environment. Thus, use of open source and custom codes requires specialized capability often tied to a small group of experts putting the accessibility of the analysis asset at risk when a given human resource terminates. Another factor that impacts the adoption of open source and custom codes is a traditional suspicion and distrust of non-commercial solvers and associated behind the scenes data handling. In this paper, we will detail the positive and negative aspects of open source and custom code relative to commercial full function codes for achieving end goal results. We will then examine how these problems are mitigated or eliminated utilizing Democratization and SimApp web interfaces. We will also discuss some aspects of when one should or should not consider using open source vs commercial code for solving FEA (Finite Element Analysis) based structural problems. Democratization will be discussed and illustrated as a method to parameterize and automate a class or family of products. Democratization automation includes the analysis from concept geometry to pre-processing, execution, and post-processing pass-fail decision making under compliance with analysis expert, regulatory and corporate standards. The Democratization automation end product is usable by non-experts which changes the resourcing model significantly for accomplishing analysis tasks. Because Democratization inherently creates a new analysis process flow, we will examine the differences in resource and cost model when Democratization is used as a framework for executing analysis tasks.

Presenter Name: Elabbasi, Nagi

Presenter Company: Veryst Engineering LLC

Presentation Title: Multiphysics Modeling of Particle Separation Using Acoustophoresis (N. Elabbasi, Veryst Engineering LLC; Lvl: 3)

Type: Presentation

Keywords:

Session Title: Multiphysics 2

Session #: 3-1

Room #: 21

Abstract:

In this paper we present a computational model of a lab-on-a-chip device for blood focusing/separation using acoustophoresis. Acoustophoresis involves the motion of particles resulting from an oscillatory acoustic field and is used for blood wash, other blood separation procedures, and acoustic levitation. The device we modeled in this paper involves a piezoelectric actuator on top of a glass *** with a rectangular channel for fluid flow. The device geometry and operating parameters selected for this paper are based on values from the literature. The model involves pressure acoustics, solid mechanics, electric field, fluid flow, and particle tracing. COMSOL Multiphysics has all these physics fields and facilitates their multiphysics coupling. We developed both 2D and 3D models. The 2D models involve a very fast solution time, but do not provide all the insight and accuracy of the 3D models. The figure below shows the particle distribution across the channel at several times, showing effective particle focusing towards channel center. The computational model helps designers select optimal dimensions, materials, operating frequency, and flow rate of the device.

Presenter Name: Farahani, Akbar

Presenter Company: Engineering Technology Associates, Inc.

Presentation Title: Multimaterial Lightweighting Using Optimization-Led Design Software (A. Farahani, Engineering Technology Associates, Inc.; Lvl: 2)

Type: Presentation

Keywords: Lightweighting, multi-material, Optimization, 3G Optimization, Accelerated, Composite, AHSS, Aluminum

Session Title: Lightweighting

Session #: 1-3

Room #: 25A

Abstract:

Lightweighting is a major focus currently in product design and development of ground transportation vehicles (passenger cars, trucks, buses) and many other consumer products. Lightweighting is a multipurpose economical solution for many industries including the environmental, construction, and transportation industries. Product cost, Co2 (34.1 MPG 2016 to 54.5 MPG by 2025) emissions, shipping cost and transportation cost reduction are just a few examples of how lightweighting impacts product design and development. For OEMs and suppliers lightweighting is an uphill battle, in which they must design and produce products that require a balance between a variety of competing factors. The factors include cost, mass, multidisciplinary performance, multimaterial function, joining and manufacturability. Furthermore, they must achieve this balance while meeting high government and consumer standards. Key to lightweighting is the use of multimaterial products. The future of product design and devlopment for Electric Vehicles (EV) and Battery Electric Vehicles (BEV) relies on these types of multimaterials. One of the most difficult tasks for manufacturers is the proper use of of materials, the choice of advanced materials (Advanced High Strength Steel, Aluminum and Carbon Fiber Plastic), placed in the proper location, with the optimal geometry, grades and gauges. To assist in the product design and development process, companies facing these challenges use a systematic optimization-led design process, software and multi-materials to create products that are lightweight, cost efficient and which meet all of the performance requirements. The presentation will give an overview of the optimized multi-material design approach of a door system using aluminum, steel and composite materials placed in the most appropriate locations for each material. The presenter will show a case study, in which the performance of a 2013 Audi A6 aluminum front door system with a steel door beam is used as a baseline. An appropriate composite material model replacement for critical components (i.e., the door inner, outer and reinforcements) is used. The performance of the multilateral (Aluminum, Steel, and composite door systems are then compared with the baseline vehicle based on six (6) major door system load cases. Accurate prediction of performance is then used ultimately for weight and cost reduction using 3G (Geometry, Grade, and Gauge) optimization. This study will evolve in providing a new direction that optimization software technologies could be used to select appropriate material kind for the most efficient lightweight door system design. This approach could be used to design any other vehicle sub-system or full vehicle body in white.

Presenter Name: Felice, Mario

Presenter Company: Ford Motor Company

Presentation Title: A Vibro-Acoustics Approach for Driveshaft Clunk Sound Prediction (M. Felice, Ford Motor Company; Lvl: 2)

Type: Presentation

Keywords: vibro-acoustics, driveshaft, NVH

Session Title: Vibro-Acoustics

Session #: 2-1

Room #: 26A

Abstract:

A Vibro-Acoustics Approach for Driveshaft Clunk Sound Prediction Jack Liu Mario Felice Ford Motor Company Romain Baudson MSC/ Free Field Technologies ABSTRACT Automotive drivetrain component design requires clearance for vehicle assembly. The metal to metal gear lash impacts from a drivetrain torque reversal excitation, such as throttle tip in or tip out event, may cause a clunk noise and vibration issue that could degrade the vehicle quality and customer satisfaction. This paper presents an innovated CAE method for a driveshaft clunk sound prediction. A hybrid elastic multi body and acoustics approach is used to simulate the radiated clunk sound from the driveshaft. The elastic multi body model consist detail chassis, steering, suspension and powertrain systems with flexible driveshafts by means of the Craig Bampton method. The three dimensional gear contact forces are calculated using analytical equations for each different gear designs in the drivetrain. The Hertzian contact theory is used to calculate the drivetrain gear impact forces due to their contact geometry design effects. The driveshaft elastic deformation during a throttle tip in maneuver is used to excite an acoustic model to predict the radiated sound along the driveshaft surface. The acoustic model consist of acoustic meshes for the driveshaft and its surface vibration excitations from the elastic multi body model and for the driveshaft surrounding boundaries to predict the acoustic cavity effect of the vehicle under body. Analytical microphones are placed consistence with the vehicle measurement conditions. It allows the time and frequency domain analyses of the driveshaft radiated sound from vehicle tip-in or tip-out events at any exterior location of the vehicle. The elastic multi body model was correlated for the pinion nose vibration and the driveshaft radiated sound using three vehicle test data. Critical driveshaft elastic modes contributing the sound radiation are identified. Different drivetrain designs, such as 4x4, 4x2 and driveshaft configuration with different wheel bases, are investigated for their clunk sound characteristics. This new method is now being used for drivetrain clunk noise and vibration assessments during early development stages.

Presenter Name: Felice, Mario

Presenter Company: Ford Motor Company

Presentation Title: Vibration and Radiated Noise Simulation of Engine Gear Rattle and Whine (M. Felice, Ford Motor Company; Lvl: 2)

Type: Presentation

Keywords: NVH, engine, gears

Session Title: NVH

Session #: 2-2

Room #: 26A

Abstract:

Vibration and Radiated Noise Simulation of Engine Gear Rattle and Whine M. Felice, M. Moetakef, A. Zouani – Ford Motor Co. J. Baumann, B. Campbell - FEV E. Pesheck, R. Baudson, M. Cabrol – MSC Software Abstract: Engines such as I3 and I4 which are not inherently balanced require balance shaft to offset their first order (I3 engine) or second order (I4 engine) vibrations. The gears transmitting the engine rotation to the balance shaft can lead to NVH issues appearing as broad band rattling noise and/or narrow band tonal whine. Engine gear rattle and whine evaluation at an early stage of the design can help to avoid this type of error state. Upfront multi-body dynamics simulation of engines including gear components can provide directions for a robust design in terms of NVH attribute to prevent gear-related NVH issues. The analytical assessment can address both the source of the excitation and the path sensitivity under different engine loading conditions of steady full load, light load, fast run-up and/or run-down coast. In order to reduce the excitation at the gear teeth, different gear microgeometry parameters (e.g., gear pressure angle, tip relief, teeth crowning, etc.) are investigated. This includes evaluation of path sensitivity, balance shaft positioning, mass and inertia distribution, component stiffening (front cover, oil pan and supporting brackets) among the actions taken into consideration to achieve robust engine noise attenuation for these error states. In this presentation, risk assessment for engine balance shaft gear rattle and whine errors states and their trade-off will be reviewed based on simulation results from use of Multi-Body Dynamics (MBD). The excitation leading to engine rattle and whine from the source through the path resulting in the engine vibration response will be thoroughly discussed. Additionally, various sensitivity analyses involving different engine loading conditions, gear backlash and gear micro-geometry levels will be presented. The output from the MBD analysis will be used to extend the engine vibrational assessment to acoustic response for gear rattle and whine. This includes generation of sound wave files simulating engine balance shaft gear rattle and whine.

Presenter Name: Floyd, Anthony

Presenter Company: Convergent Manufacturing Technologies Inc

Presentation Title: ITEA VMAP – A New Interface Standard for Integrated Virtual Material Modelling in Manufacturing Industry (A. Floyd, Convergent Manufacturing Technologies Inc; Lvl: 2)

Type: Workshop

Keywords:

Session Title: VMAP: Defining Standards for Material Data Transfer in Manufacturing Virtual Simulation

Session #: 3-3

Room #: 25B

Abstract:

VMAP is a project organized by ITEA, a European-based EUREKA Cluster program supporting innovative, industry-driven, pre-competitive R&D projects in the area of Software-intensive Systems & Services (SiSS). Project funding is provided by the related national research agencies. The project aims to develop a standard for the transfer of material data within complex Computer Aided Engineering (CAE) simulation workflows such as those found in virtual manufacturing simulation process and product design. This 3-year project – which began in September 2017 - is led by Fraunhaufer SCAI (Sankt Augustin, Germany) and has a total budget of approximately 16M€ (~$19M USD) for almost 123 person-years' effort. The collaboration is between 30 partners from Austria, Belgium, Canada, Germany, the Netherlands and Switzerland and includes manufacturing companies, software vendors, engineering companies, materials institutes, and universities. The transfer of virtual material information within virtual engineering workflows between many incompatible interfaces currently causes considerable additional cost and complex manual adaptation leading to inflexible IT solutions, loss of information and significant delays in the overall design process. The standardization of material interfaces in CAE is therefore vital for all industry segments where material behaviour is central to product and process design. The VMAP project will generate universal concepts and open software interface specifications for the exchange of material information in CAE workflows resulting in an open software interface standard. The advantages of this integrated material handling will be demonstrated by the following industrial user cases from different material categories, manufacturing domains, and industry segments (industrial end-user partners are shown in brackets): - Extrusion blow moulding of plastic drums (Rikutec) - Composites for lightweight automotive vehicles (Audi) - Injection moulding of various components for different applications including fibre reinforced components for crash applications (4a Engineering) - Additive manufacturing of plastic parts (Robert Bosch) - Hybrid multiscale modelling for shaver products (Philips) - Aerospace composite manufacturing (Convergent Manufacturing Technologies) These simulation processes include many simulation stages from manufacturing process simulations to product assessment simulations and use approximately 20 commercial software applications between them. The Implementation of extended CAE software interfaces will be realized including translation tools that follow the open interface specification. Interoperable virtual material models and a seamless transfer of material data history in a CAE workflow will enable industrial users to develop and produce better products in a shorter timescale using more efficient manufacturing processes. Interface standards will also help CAE software developers and vendors to achieve further virtual material models that can easily be integrated into holistic design, simulation and optimization workflows. It is considered that this can significantly benefit Europe's future manufacturing market where material technology is a key factor, especially in the rapidly emerging market of additive manufacturing for metal and plastics. This new standard will be supported beyond the project's lifetime by an open and vendor-neutral 'Material Data Exchange Interface Standard' community that will provide best-practice guidelines for the community and will ensure that standardization efforts continue into the future. This session will consist of two parts: a review of the VMAP project, its case studies, and the work done to date, and then a participatory session where attendees will be able to provide their input and comments about their own CAE workflows, and needs that they would like to be addressed by this standardization effort.

Presenter Name: Fouladi, Kamran

Presenter Company: InfoMec Consulting

Presentation Title: CFD-Based Optimization of Micro Vortex Diodes (K. Fouladi, InfoMec Consulting; Lvl: 2)

Type: Presentation

Keywords: Micro vortex diode, diodicity, pressure drop, Simulation, CFD, optimization, Design of Experiment, Response Surface Method

Session Title: CFD: Optimization

Session #: 1-3

Room #: 26A

Abstract:

Microfluidic devices have shown great potential for biomedical applications. These devices may be used in drug delivery, biological detection, cellular analyses, tissue engineering, etc. Among fluidic microsystems, microvalves can play an essential role in fluid transport and control phenomena. Microvalves allow the user to control the fluid macroscopic parameters. A major class of microvalves are valves that can be actuated mechanically. Microvalves with moving mechanical parts (MVMPs) can pose major manufacturing difficulties. Additionally, these valves may have reliability issues as they can fail due to deterioration of the moving parts exposed to prolonged and repeated movements. The repair or replacement of MVMPs can be either cost prohibitive or unsafe for some applications. An alternative to MVMPs are microdiodes, which offer high resistance to flow in one direction and much smaller resistance in the opposite direction. An example of such a device is the vortex diode. The vortex diode is designed with a disc-shaped chamber with an axial port and a tangential port. It allows the flow in the forward direction enter at the center of the device and exit at the tangential port with relatively small pressure drop. In the reverse direction, the flow enters the tangential port creating a rotating and swirling flow in the diode chamber and then exits at the axial port. The swirling flow results in significantly larger pressure drop in the reverse direction compared to the forward direction. The present study is focused on developing a two-step computationally-based approach for design and optimization of micro vortex diodes. The numerical modeling for the flow analyses and optimization of the micro vortex diode was performed using the commercial software ANSYS Fluid with finite volume-based ANSYS Fluent as the pressure-based flow solver. A numerical design optimization based on the Design of Experiment and Response Surface Method was then employed to improve the efficiency of a micro vortex diode using geometrical parameters such as diode diameters, diode depth, and tangential port height on the performance of the micro vortex diode. The numerical investigation indicated that all three parameters have significant effects on diode performance. The increase in diode depth increased the diode diodicity. The additional depth space may allow more room in the chamber for the flow to swirl around resulting in additional pressure losses in the reverse direction. The diodicity was also increased with increase in tangential port height. The increase in height means larger area for the tangential port. With constant volume flow rate, the increase in the area results in lower velocity or higher pressure at the tangential port. The higher tangential port pressures were observed in both forward and reverse directions with pressure values in the reverse direction greater compared to the forward direction. Conversely, larger diode diameters resulted in smaller diodicity as larger diameters result in lower pressure losses in the reverse direction, which may be due to lower viscous losses. The results of the optimization study suggested an optimal design with about 69% improvement in efficiency compared to the reference design.

Presenter Name: Fouladi, Kamran

Presenter Company: InfoMec Consulting

Presentation Title: NAFEMS Training: CFD for Structural Designers & Analysts (K. Fouladi, InfoMec Consulting; Lvl: 1)

Type: Training

Keywords:

Session Title: NAFEMS Training: CFD for Structural Designers & Analysts

Session #: 2-1

Room #: 20

Abstract:

Structural engineers often need to resort to more sophisticated thermal fluid simulations to obtain boundary conditions, loading, performance, etc. for their designs and analyses. This course aims to introduce the essential principles of fluid dynamics, important flow phenomena, and basics of CFD process to structural engineers for their multidisciplinary problems. Adapted from a NAFEMS e-learning course, CFD for Structural Designers and Analysts, this condensed version provides a brief overview on important concepts and principles of fluid dynamics, CFD, turbulence, and heat transfer relevant to structural analyses will be discussed through simple examples and case studies.

Presenter Name: Fouladi, Kamran

Presenter Company: InfoMec Consulting

Presentation Title: NAFEMS Training: Practical Introduction to CFD (K. Fouladi, InfoMec Consulting; Lvl: 1)

Type: Training

Keywords:

Session Title: NAFEMS Training: Practical Introduction to CFD

Session #: 2-2

Room #: 20

Abstract:

This course provides a view into practical application of CFD in real life applications and the challenges faced due to presence of turbulence, heat transfer, phase changes, and movement of boundaries. Adapted from a NAFEMS e-learning introductory CFD course, this condensed version briefly describes the steps in the CFD process and provides benefits and issues for using CFD analysis in understanding of complicated flow phenomena and its use in the design process. Through a simple and moderately technical approach, this course covers topics such as the role of CFD, basic formulation, governing equations and use of model equations, steps in CFD process, need for turbulence modeling, and CFD best practices.

Presenter Name: Fouladi, Kamran

Presenter Company: InfoMec Consulting

Presentation Title: NAFEMS Training: Elements of Turbulence Modeling (K. Fouladi, InfoMec Consulting; Lvl: 2)

Type: Training

Keywords:

Session Title: NAFEMS Training: Elements of Turbulence Modeling

Session #: 3-1

Room #: 20

Abstract:

Successful application of turbulence modeling requires engineering judgment depending on physics of the flow, accuracy, project requirements, turnaround time, and available computational resources. This course is focused on understanding turbulence, need for turbulence modeling, and various modeling approaches. Adapted from a NAFEMS e-learning course, Elements of Turbulence Modeling, this condensed version briefly covers topics such as turbulent flow characteristics, eddies in turbulent flows, turbulence production, energy cascade, scales in turbulent flows, simulation strategies, principles of turbulence modeling, wall effects and choosing a model.

Presenter Name: Francis, Zack

Presenter Company: ANSYS Inc.

Presentation Title: Uses and Applications of Additive Manufacturing Process Modeling (Z. Francis, ANSYS Inc.; Lvl:)

Type: Presentation

Keywords: Additive Manufacturing, Simulation, Process Modeling, 3D Printing

Session Title: Additive Manufacturing Process Analysis 2

Session #: 1-2

Room #: 25B

Abstract:

Additive manufacturing (AM) is a rapidly growing industry with the ability to produce a wide variety of unique parts. While additive manufacturing presents a large opportunity for manufacturers, many encounter problems with failed builds without necessarily knowing the root cause of the issue. Simulation of the additive process can aid in the prevention of build failures and help identify methods to fix existing issues. This reduces the number of iterations typically required in design for additive manufacturing and gives manufacturers more confidence in how reliably a part can be built. Additive manufacturing simulation capabilities have been developed to complete a thermal-structural analysis of an AM build using a layer by layer approach. A Coupled thermal and structural model is well suited to accurately predict thermal and structural conditions throughout the build process and post-processing steps. Analysis of deformation, stresses, strains, and other outcomes that occur during and after the build can help highlight issues in key or problems areas of the part. Drawing attention to these regions gives designers and manufacturers the ability to identify problems in the manufacturing process before resources are spent on machine time or material costs. Additive manufacturing models can enable the analysis of important results throughout the additive buildup, heat treatment, and support removal. Placed in a design workflow with other design tools, additive manufacturing simulation can help designers ensure success during the manufacturing process in addition to the intended use for a particular design. A complete workflow allows for part design optimization for the use case, and can identify whether the design can be successfully created with additive manufacturing. Simulation results are presented for multiple parts and compared against experimental measurements with good agreement. Completing analysis on an AM process simulation, rather than a physically built part, can not only save valuable resources, but also allows designers to progress through design iterations more quickly.

Presenter Name: Fredriksson, Lars

Presenter Company: Altair Engineering GmbH

Presentation Title: Multidisciplinary Car Body Optimization for Balanced Design Weight, Cost and Vehicle Performance (L. Fredriksson, Altair Engineering GmbH; Lvl:)

Type: Presentation

Keywords: Multiple-disciplinary Optimization, MDO, Vehicle Structure, Weight, Cost, Performance

Session Title: Optimization 2

Session #: 3-1

Room #: 26A

Abstract:

The automotive industry is a fiercely competitive global industry and producing a vehicle structure which exhibits an optimum balance between weight, vehicle performance and cost has become a commercial necessity. An example of the financial benefits of achieving competitive weight is illustrated by the recent and planned stricter legislations and penalties concerning emissions from passenger vehicles. The strive for even better balance between attributes, mass and costs calls for new and/or modified development methods which support the design engineers optimally to maintain control of the complex development process and simultaneously reach the best balance of attributes. An important strategy to both provide better control of development and to reach a best possible balance of attributes is to further intensify the cooperation between, and integration of, design engineers and CAE optimization experts. By using numerical optimization as the backbone technology, CAE can directly and actively support vehicle body design much more efficiently than today to drive design to increased maturity and to reach desired design targets. Altair denotes this development philosophy “Simulation Driven Design”, which is defined as the strategic and systematic usage of optimization in order to generate design alternatives, trade-off information, design sensitivities, and balanced designs to actively support the vehicle design process. The key requirements on “Simulation Driven Design” in order to be used on industry relevant problems (e.g. body and/or platform development) are the following: 1. Design decision feedback must be provided timely within design milestones and under compressed quality gate schedule of the OEM 2. Processes need to be able to handle the high complexity of load cases, attribute requirements and a complex organizational setup of the OEM 3. “Simulation Driven Design” processes need to be integrated without requiring substantial changes of existing development processes of the OEM The reluctance of the industry to adopt MDO for body / full vehicle design is strongly associated with the failure to fulfill one or more of the above requirements associated with simulation driven design. Due to the complexity to synchronize different attribute models and due to the size of the problem to solve, most MDO approaches have so far failed to deliver output and thus feedback to design within acceptable time constraints. By the time the results are available, the state of the design already changed such that results are less relevant. Out of the several “Simulation Driven Design” processes Altair provides which fulfill the requirements above; Altair Multi-Disciplinary Optimization (MDO) is significant as it brings usability, efficiency, and accuracy to a complex design process. Altair MDO comes with a streamlined interface that significantly simplifies the setup, execution, and post-processing of an MDO study. It is also powered with innovative methods to increase the efficiency and effectiveness of the process so that the number of expensive simulation runs to reach to a desired quality of results is minimized. This presentation will demonstrate the Altair MDO process and explain how it fulfills the requirements of a “Simulation Driven Design” philosophy. It will also demonstrate how the Altair MDO process can be used to solve full-scale coupled multi-disciplinary problems including attributes such as crash, occupant safety, body NVH, vehicle NVH and ride & handling.

Presenter Name: Frondelius, Tero

Presenter Company: Wartsila Finland Oy

Presentation Title: Micromechanical Modeling of the Role of Inclusions in High Cycle Fatigue Damage Initiation and Short Crack Growth (T. Frondelius, Wartsila Finland Oy; Lvl: 3)

Type: Presentation

Keywords: Micromechanics, inclusion, fatigue damage

Session Title: Advanced Materials Characterization

Session #: 1-2

Room #: 25A

Abstract:

Multiscale microstructural and micromechanical modeling has arisen as a candidate to improve upon the classical methodologies for evaluation of fatigue crack initiation and propagation, both with respect to improving our understanding of the fundamental material deformation and damage processes as well as in establishing more accurate design rules for engineering purposes. By exploiting methodologies of multiscale materials modeling it is envisioned that engineering material properties can be directly computed based on microstructural scale analysis of single crystal plasticity and damage evolution. The models can be then further used to simulate the various dependencies affiliated with fatigue damage arising from material microstructure, such as the effects of stress triaxiality, compressive loading and overall complex stress states. The overall goal of these efforts is the general decrease in empirism, inaccuracy and affiliated uncertainty in the fatigue modeling and design chain. Current work utilizes a novel crystal plasticity coupled damage model to evaluate inclusion to steel microstructure interactions with the objective of better understanding and quantifying the role inclusions play with respect to nucleation and growth of microstructure scale fatigue cracks. The approach is microstructural, i.e. material characteristics such as microstructural morphologies, individual phases and inclusions are included explicitly in the numerical finite element models and the subsequent behavior with respect to single crystal deformation and initiation of fatigue damage can be directly witnessed. A micromechanical model where crystal plasticity and damage are directly coupled is employed in the analysis. As such, the appearance of material damage during cyclic loading at microstructural cleavage planes can be observed based on single crystal slip as well as interactions arising from the stress-strain states of the inclusion and the metallic microstructure. A case study is carried out for primarily martensitic quenched and tempered steel for machine construction. The mechanisms of deformation during cyclic loading and the role of differing loading ratios are assessed along with implications with respect to fatigue damage. The role of inclusion properties and its size relative to the martensitic microstructure are addressed and discussed. Damage evolution in relation to inclusion characteristics is found to be in line with classical empirical criteria utilized in pursuing validation of the material models and the computational methodology. The results suggest potential ways of exploiting multiscale materials modeling in design of fatigue resistant microstructures, optimization of material solutions and in improved fatigue design of products and components.

Presenter Name: Gatscher, Jeff

Presenter Company: Schneider Electric North America

Presentation Title: Technology Tools Enabling Seismic Qualification of Equipment for Essential Building Applications (J. Gatscher, Schneider Electric North America; Lvl: 2)

Type: Presentation

Keywords: seismic certification, automation, knowledge management, earthquake engineering

Session Title: Simulation Governance: Collaboration 2

Session #: 1-2

Room #: 24

Abstract:

Seismic conformance for essential building applications is a mandatory requirement to sell electrical and mechanical equipment into North American markets. The building codes used in the United States and Canada specify earthquake demands in terms of ground motion hazard maps. Seismic testing of electrical and mechanical equipment is required to satisfy building code compliance expectations. Thus, seismic conformance is a matter of validating equipment seismic capacity exceeds the ground motion demand at the location of equipment installation. This seemingly straightforward concept is fraught with technical complexities. Building code earthquake requirements have matured and today are highly sophisticated. Earthquake demands are defined as a function of latitude/longitude coordinates, geotechnical site classifications, response spectrum parameters and floor spectrum transformations. This requires geocode database lookups, interpolations, spectrum manipulations and validation checks. Equipment seismic capacity involves product line rationalization to identify the right test candidates that can be tested to qualify highly variable product platforms. Addressing the technical challenges involved in modern day seismic qualification requires specialized subject matter expert (SME) knowledge that is not readily available within most equipment manufacturers. The goal of this paper is to describe earthquake engineering technology enablers that can capture and democratize SME knowledge and disseminate it to the non-specialist. There are three seismic qualification process elements that can greatly benefit from employing technology tools. On the front end is test data management and product line capacity management and on the back end is product order compliance validation. Each process step requires SME expertise to ensure seismic conformance is being met. By leveraging web technology, each step can be streamlined and automated to support widespread usage by the non-specialist, thus permanently capturing SME knowledge while driving down engineering overhead cost. The development of custom software is the traditional approach for creating targeted web technology. This approach can be used to address specific earthquake engineering process algorithms. However, custom software development is expensive and requires continued maintenance by software professionals. This implementation model is not conducive when product design teams need to “own the technology.” A better solution is to use a commercial software approach to web tool development, such that design engineers can develop and maintain the applications without the overhead of IT and software coders. The approach described in this paper utilizes the later method by leveraging the capabilities of EASA Software in conjunction with embedding earthquake engineering SME knowledge. The result is a set of highly specialized engineering web tools that are maintained by product engineers and not software or IT professionals. The net result is increased efficiency, decreased overhead cost, SME knowledge capture and 100% assurance of attaining compliance with building code earthquake requirements for equipment orders in the United States and Canada. EASA is a codeless application development platform that enables authoring and deployment of web applications which can drive underlying process algorithms. Three EASA applications are described herein that support execution of the three seismic qualification process steps defined above: test data management, product line capacity management and equipment order validation.

Presenter Name: Genc, Kerim

Presenter Company: Synopsys

Presentation Title: Computed Tomography (CT) Based Inspection and Finite Element (FE) Simulation of Additive Manufactured (AM) Parts (K. Genc, Synopsys; Lvl: 2)

Type: Presentation

Keywords: Computed Tomography, Image Based Meshing, Additive Manufacturing, Simulation, Inspection

Session Title: Analysis & Certification of 3D Printed Parts

Session #: 1-3

Room #: 25B

Abstract:

Additive Manufacturing (AM) of metal parts is becoming more common as an alternative to traditional approaches due to the flexibility in design from which it allows designers to manufacture parts. However, the uncertainties of AM parts in terms of accuracy, quality, strength and reliability are still relatively high. Simulation techniques are now being incorporated into the design process to help improve the quality of the AM design process, reduce weight and ensure a higher probability of a successful build. Despite these efforts, however, there is still uncertainty in the differences between as-designed versus as-built AM parts, which leads manufacturers to ask the following question: “What are the differences between my design and the part that is actually manufactured via AM, and more importantly, how will these differences affect performance in the real world?” Companies are already spending hundreds of thousands to millions of dollars on 3D imaging technology like industrial Computed Tomography (CT) scanners for inspection, non-destructive evaluation and reverse engineering of Additive Manufactured (AM) parts. From CT scans, users can typically understand things like porosity, crack/defect size, deviations from design etc. However, these workflows do not provide an understanding of how these defects and deviations from design will affect performance in the real world. In this paper, we describe how the three groups, CT-imaging, AM and FE simulation, are just now starting to connect because of a need to better understand the performance of the real as-manufactured part, not just a CAD design ideal. Typically, due to the knowledge gap between these groups, the adoption of this workflow from the 3D scan to a realistic FE simulation can be tortuous with engineers using a mix of open source, in-house and/or commercial tools to create an inefficient workflow that can be an expensive drain on internal time and resources. We will demonstrate a Case Study proof of concept workflow where ANSYS tools are used to design a lightweight bracket, which is built using the laser powder bed AM in a titanium alloy (Ti6Al4V), is then scanned in a North Star Imaging (NSI) CT scanner and then Simpleware Software is used to inspect the geometry and generate an FE mesh, which is exported to ANSYS for simulation. This workflow allows users to close the design loop and truly understand how any defects in the manufactured part can affect performance in the real world.

Presenter Name: Genc, Kerim

Presenter Company: Synopsys

Presentation Title: Brain Bulging: A Personalised Model (K. Genc, Synopsys; Lvl: 2)

Type: Presentation

Keywords: soft matter, hyperelasticity, swelling, finite element analysis, neuromechanics, brain, craniectomy, kinematics,

Session Title: Biomechanics

Session #: 2-1

Room #: 26B

Abstract:

The brain sits in a highly tuned environment, where the mechanical conditions are closely controlled. When this environment is altered, most commonly during trauma, stoke, infections or tumors, an increase in intracranial pressure can be life threatening. Pressure inside the skull reduces blood and oxygen supply to the brain causing further damage [1]. As a last resort neurosurgeons perform a decompressive craniectomy – cutting away part of the skull, exposing the brain to let the swelling "buldge out" thus reducing the elevated pressure [2,3]. However, this procedure leaves the brain exposed and prone to infection, while damage to the tissue during the "bulding" process may cause sever long term disabilities [4]. Understanding the correct timing for the procedure along with the location and size of the skull opening is critical to minimising long-term side effects. Although this surgical operation has been performed since the 1900s [5], little is known about the mechanics of what happens during this process with regards to deformation, stress and strain exhibited at the edge of the skull opening. This study of "buldging" brains illustrates how swelling-induced deformations propagate across the brain when opening the skill. In particular, studying the kinematics of how this procedure releases an elevated intracranial pressure at the expense of inducing local zones of extreme strain and stretch. This work builds on a mathematical model (a continuum model where swelling brain tissue is modelled as an elastically incompressible Moony Rivlin solid) [6], and uses a personalised head model generated from MRI for finite element simulations. The study covers craniectomy under different conditions by varying swelling area, skull opening size and skull opening location. The displacement, deformation, radial and tangential stretches and maximum principle strains are reported. Though systematic simulation the common features and trends were identified. In all cases, a unified stretch pattern is shown. This includes three extreme stretch regions: • a tensile zone deep within the buldge, • a highly localised compressive zone around the opening, • a shear zone around the opening. This means region 1, deep within the buldge, is most vulnerable to damage by stretching the axons. Axons are also known as "nerve fibres", and are the long thin part of the nerve cells used to transfer information to different neutrons, muscles and glands. This axonal stretch is in agreement with analytical predictions [7]. Regions 2 and 3 near the craniectomy edge, are most vulnerable to damage to the axons through shear forces and herniation. Axonal shear is shown here to be a potential factor in long term brain damage from decompressive craniectomy. The simulations performed here, suggest that a frontal craniectomy, which provides a larger opening, creates significantly lower displacement, strains and stretches in comparison with a unilateral craniectomy (openings on the side of the skull). This research along with mathematical models and computational simulations can help identify regions of extreme tissue kinematics. This approach could guide neurosurgeons to optimize the shape and position of the craniectomy with the goal to avoid placing the craniectomy edge near functionally important regions of the brain. References: [1] Cooper et. al., New Engl. J. Med. 364 (2011) 1493-1502. [2] Kolias et. al., Nature Rev. Neurol. 9 (2013) 405-415 [3] Quinn et. al., Acta Neurol. Scandinav. 123 (2011) 239-244. [4] Hutchinson et. al, Acta Neurochir. Suppl. 96 (2006) 17-20. [5] T. Kocher, Die Therapie des Hirndruckes. In: Verlag H, editor. Hirnerschütterung, Hirndruck und chirurgische Eingriffe bei Hirnkrankheiten. (1901) 262–266 [6] Weickenmeier et. Al.,Journal of Elasticity. (2017) 129–197 [7] Goriely et al., Phys. Rev. Letters 117 (2016) 138001

Presenter Name: Genc, Kerim

Presenter Company: Synopsys

Presentation Title: Moving Beyond CAD - 3D Image-Based Simulation of Real World Geometries (K. Genc, Synopsys; Lvl: 1)

Type: Workshop

Keywords: Computed Tomography, Image Based Meshing, Life Sciences, Materials, Industrial Manufacturing

Session Title: Moving Beyond CAD - 3D Image-Based Simulation of Real World Geometries

Session #: 2-3

Room #: 21

Abstract:

Companies are spending hundreds of thousands to millions of dollars on 3D imaging technology such as industrial Computed Tomography (CT) scanners for inspection, non-destructive evaluation and reverse engineering of manufactured parts. At the same time, they are spending just as much, if not more, on computational Finite Element (FE) simulation to run virtual tests on CAD-based designs of these same manufactured parts. These two groups, imaging and FE simulation, are just now starting to connect because of a need to run simulations on geometries that give a better representation of the “as-manufactured” part, not just a CAD design ideal. Due to the increased accessibility of high fidelity 3D imaging, as well as the increased ease of use with simulation tools, there is a wide spectrum of application areas for this functionality including the Life Sciences, Materials and Industrial applications. However, due to the knowledge gap between imaging and simulation groups, the adoption of this workflow from the 3D scan to a realistic FE simulation can be tortuous with engineers using a mix of open source, in-house and/or commercial tools to create an inefficient workflow that can be an expensive drain on internal time and resources. Simpleware has software and services that offers a solution that fills this gap in knowledge by providing the fastest time to accurate simulation-ready meshes from 3D image data. Since NAFEMS attendees tend to be experts in FE simulation, the goal of this workshop is aimed at those interested in learning the best practices of CT scanning, image reconstruction (as obtained from CT) and image-based meshing to generate the models they need for computational simulation in FE tools. We will discuss the use of North Star Imaging (NSI) CT-Scanners to generate high quality 3D image data of the scanned part. The workflow of processing this 3D image data to create meshes for Life Sciences, Materials, and Industrial applications will then be outlined and demonstrated. Attendees will learn how the robust and automated meshing algorithms in Simpleware Software can convert multiple segmented regions into multipart, watertight and analysis-ready models . Finally, we will give an overview of how these FE meshes can be deployed and solved in simulations tools, such as Simulia Abaqus.

Presenter Name: Gentzsch, Wolfgang

Presenter Company: UberCloud

Presentation Title: Introduction to Cloud Computing for Engineering Simulations – With Hands-On Practice (W. Gentzsch, UberCloud; Lvl: 2)

Type: Training

Keywords: CAE, Cloud Computing, HPC, Private Cloud, Public Cloud, Hybrid HPC, Cloud Challenges, Cloud Benefits, ANSYS, Dassault, SIMULIA, COMSOL, Numeca, OpenFOAM, Transvalor

Session Title: Introduction to Cloud Computing for Engineering Simulations with Hands-On Practice

Session #: 3-2

Room #: 25C

Abstract:

This training course provides a pragmatic step-by-step introduction into cloud computing for CAE applications. While similar courses in the past often provided introductions mainly for advanced early adopters, this short course has been especially developed for the majority of engineers. Following recent findings and suggestions from market analysts like Gartner and Hyperion/IDC we believe that now is the time to add cloud computing as an additional computing tool to your in-house resources because, over the last two years, cloud computing for CAE applications has been greatly simplified, previously insurmountable cloud hurdles removed, and the cost of using cloud resources successively reduced because of healthy competition in the high performance cloud computing market. The benefits for small and medium size manufacturers of running CAE applications on high performance computing (HPC) resources are widely acknowledged in the meantime: such as developing better quality products; achieving high return on investment (ROI); reducing product failure early in design; and shorter time to market; leading to increased competitiveness and innovation. Why then are many engineers running simulations still just on their workstations, although more than half of the engineers (according to the US Council of Competitiveness) are regularly limited by the performance of their workstations? The main reason is that in-house HPC servers are often coming with high investments and maintenance cost, and long and painful procurement and approval processes. And for many, Return on Investment (ROI) from HPC is not clear, although it is expected to be huge according to an IDC study on ROI in HPC. The second alternative for manufacturers to experience the benefits of HPC, without having to buy and operate their own HPC system, is offered by cloud computing. CAE in the Cloud enables engineers to both continue using their workstation or in-house servers for daily design and development, and to submit larger, complex, time-consuming jobs to the cloud. Major benefits of the CAE Cloud solution are on-demand access to 'infinite' resources, pay per use, reduced capital expenditure, greater R&D and business agility, and dynamically scaling resources up and down as needed. This training course will begin with a discussion of today's benefits and challenges of cloud computing for CAE simulations. We will look at the cost for using in-house versus cloud resources, compare cloud licensing models from different software providers, discuss 'hot topics' like trust and security, data transfer, and access to cloud resources, and briefly describe the (currently) most popular model of Hybrid HPC. The last part of the training will take participants hands-on to the cloud. We will provide real-time instant access to simulation codes like ANSYS Fluent and Mechanical, COMSOL Multiphysics, Dassault Systemes' Abaqus, Numeca FINE/Marine and FINE/Turbo, Siemens STAR-CCM+, Transvalor FORGE, and OpenFOAM, with ready-made examples which participants can run in the cloud.

Presenter Name: Gentzsch, Wolfgang

Presenter Company: UberCloud

Presentation Title: Novel Software Container Technology Enabling Ease of Access and Use of CAE Applications in the Private and Public Cloud (W. Gentzsch, UberCloud; Lvl: 2)

Type: Presentation

Keywords: CAE, Simulation, HPC, Cloud, Containers, Docker, Living Heart Project

Session Title: Cloud

Session #: 3-3

Room #: 25C

Abstract:

Engineers still struggle to access and use the cloud for their complex simulations. Application software containers make all these cumbersome steps obsolete; they are pre-packaged, fully portable, easy to access and use, and without loss of performance; no need to learn anything about high performance computing nor the cloud, thus enabling - what we call - the democratization of HPC for engineering applications. In this contribution we will introduce novel software technology based on Docker containers which we have developed over the last four years with more than two dozen features needed to run engineering High Performance Computing (HPC) applications in a simple, seamless, and effective way, with access and use identical to the engineer's desktop. These HPC containers are software packages designed to deliver all the tools an engineer needs, ready to execute, in an instant. The engineer's application software is pre-installed, configured, and tested, in the container, and running on bare metal or in VMs, without loss of performance, on private and public clouds. These containers are widely applicable and can be used for any simulation software and complex engineering workflow; they can be packaged just ones, and then run everywhere, on any Linux platform. We will demonstrate these container benefits with presenting a life sciences simulation use case from the Living Heart Project, performed by researchers from the Living Matter Laboratory at Stanford University, and supported by Living Heart Project members from SIMULIA (Abaqus 2017), Advania (cloud resources), and UberCloud (software containers, and sponsored by Hewlett Packard Enterprise and Intel. It is based on the development of a Living Heart Model (LHM) that encompasses advanced electro-physiological modeling. The goal of this project was to create a biventricular finite element model to be used to study drug-induced arrhythmias of a human heart. Before a new drug reaches the market, pharmaceutical companies need to check for the risk of inducing arrhythmias. Currently, this process takes years and involves costly animal and human studies. In this project, the Living Matter Laboratory of Stanford University developed a new software tool enabling drug developers to quickly assess the viability of a new compound. This means better and safer drugs reaching the market to improve patients' lives. Cardiac arrhythmia can be an undesirable and potentially lethal side effect of drugs. During this condition, the electrical activity of the heart turns chaotic, decimating its pumping function, thus diminishing the circulation of blood through the body. Some kind of cardiac arrhythmia, if not treated with a defibrillator, will cause death within minutes.

Presenter Name: Ghosh, Ram

Presenter Company: Stony Brook University

Presentation Title: Numerical Analysis of Transcatheter Aortic Valve Performance: The Effect of Heart Beating and Blood Flow (R. Ghosh, Stony Brook University; Lvl: 1)

Type: Presentation

Keywords: TAVR, FEA, CFD, FSI, Medical Devices, Blood Flow

Session Title: Medical Devices 1

Session #: 2-2

Room #: 26B

Abstract:

Transcatheter aortic valve replacement (TAVR) is a minimally invasive procedure for high to intermediate surgical risk patients with end-stage calcific aortic valve disease, which often represents their only life-saving treatment. Despite its promising outcomes, complications such as paravalvular leakage (PVL), valve migration, and aortic root rupture may hamper the expected expansion of TAVR to lower risk patients. There are numerical studies that attempted to address these complications but their focus was only the deployment of the valve, thus neglecting the post-deployment interaction of the valve during heart beating. Simulia Living Heart Human Model (LHHM) is a validated 3D dynamic model of an adult heart that includes physiologically realistic structural and electrical behaviors. The electrical analysis is used to compute the pacing of the heart, which is in turn utilized to derive the myocardium stresses to control the mechanical contraction and relaxation of the chambers. In this study, the LHHM capabilities will be used to examine two commercially-available types of TAVR stents in a modified version of the LHHM that includes coaptation calcification patterns in the native aortic valve (AV). The heart wall motion will be then extracted from the LHHM and employed on patient-specific models to evaluate their performance in realistic diseased anatomies. The proposed methodology is based on the following steps: (a) TAVR valve deployment in LHHM; (b) Fluid-Structure Interaction (FSI) analysis to compare TAVR valve hemodynamics with healthy and diseased AV; (c) TAVR deployment in patient-specific models with annular motion; (d) Computational Fluid Dynamics Analyses to assess risk of post-deployment PVL. The self-expandable Evolut R (Medtronic, Inc., Minneapolis, MN) and the balloon-expandable SAPIEN (Edwards LifeSciences, Inc., Irvine, CA) stents were modeled. The crimping process and deployment was simulated and parameterized in three locations (aortic, midway and ventricular) following three cardiac cycles. The TAVR stent equipped with the prosthetic leaflets in the deployed configuration was then used to further study the valve hemodynamics via FSI. Specifically, the LHHM inner ventricular surface contraction is implemented as boundary condition (BC). A body-fitted sub-grid geometry resolution method was chosen during the FSI fluid solution. The deployed valve's structural mechanics and blood flow were modeled in Abaqus Explicit 6.14-6 and FlowVision 3.10.01 (Capvidia NV, Leuven, Belgium) respectively. A 2-way strong implicit coupling was used between these two partitioned solvers using FlowVision Multi-Physics Manager 3.10.01. The solution of the blood flow was successfully coupled with the LHHM with healthy and diseased AV, thus allowing to assess the hemodynamics in the heart throughout the cardiac cycles. Implantation of the TAVR valves in the beating LHHM is currently being simulated under the same conditions. In order to incorporate more accurate diseased anatomies, the same devices are being deployed on CT-based calcified aortic roots of patients who suffered mild-to-moderate PVL and cardiac conduction abnormality post-procedurally. The motion of the AV annulus is extracted, normalized and applied as BC. The stent anchorage to the calcified native leaflets is monitored over time. The fluid domain is then extracted and a transient flow analysis are currently conducted in Ansys Fluent 18.1 (Ansys, Canonsburg, PA) to quantify PVL for each procedural scenario investigated. This study intends to offer a comprehensive methodology to evaluate TAVR valves' performance during successive cycles of a beating heart. Coupling successfully FSI simulation with the LHHM allows to investigate the effect of deployed TAVR valve on the blood flow dynamics and vice versa. This information can be employed to drive TAVR deployments in patient-specific anatomies to better understand the mechanisms behind the reported complications. The suggested novel methodologies can ultimately be used in the future for minimizing the risk of clinical complications by enhancing procedural planning.

Presenter Name: Glatt, Ilona

Presenter Company: Math2Market GmbH

Presentation Title: How Does the Microstructure of the Cathode Material Influence the Performance of the Battery? (I. Glatt, Math2Market GmbH; Lvl: 1)

Type: Presentation

Keywords: Simulation, GeoDict, in silico, optimization, material research, BEST, tortuosity, pore size distribution, porosity

Session Title: Electrical 2

Session #: 1-2

Room #: 26C

Abstract:

Improving battery materials is a challenge. The desired properties are not independent and sometimes, even conflicting. For example, a material well suited for fast charging does not necessarily provide a high capacity. Unfortunately, experiments aimed at improving electrode materials are complex and time consuming. Nowadays, most simulations of battery performance are conducted on a cellular level and above. Due to the very small particles in cathode materials, the access to the microstructure is complicated, both experimentally and with common imaging techniques. However, recent advances in imaging techniques, such as x-ray tomographic (CT) microscopy and focused-ion beam scanning electron microscope (FIB-SEM) tomography, provide access to inspecting the porous microstructure of electrodes. Consequently, the importance of the microstructure in influencing the performance of the battery has become increasingly evident. [e.g. M. Ebner, D.-W. Chung, R. E. Garcia, and V. Wood. “Tortuosity Anisotropy in Lithium-Ion Battery Electrodes,” Advanced Energy Materials,4, 1614 (2014)]. The case study presented shows an approach to overcome this main challenge in battery research. FIB-SEM scans of the cathode material of a commercially available battery are imported into the simulation software GeoDict and used to produce a 3d model of the structure. A virtual twin is created by digital cloning based on the 3d model from the imported scans. For this, the structure generation modules available in the software package GeoDict are used. The pore size and grain size distributions are systematically and easily modified during the generation with GeoDict to create a large set of electrode material models with varying, but well-specified microstructural properties. Every electrode material in the set is tested in a battery simulation with BEST (Battery and Electrochemistry Simulation Tool), which has been integrated into GeoDict. The characteristic properties of the battery, such as life-time, possible charge rates etc. are influenced in this manner. This approach gives us the possibility to improve battery materials by altering their microstructure, while directly getting feedback on their performance as a battery material. Thus, we can digitally design the next generation materials whose performance exceeds that of the original material.

Presenter Name: Glatt, Ilona

Presenter Company: Math2Market GmbH

Presentation Title: How to Improve Battery Performance by Digitally Optimizing the Microstructure of the Electrodes (I. Glatt, Math2Market GmbH; Lvl: 1)

Type: Workshop

Keywords: Simulation, GeoDict, in silico, optimization, material research, BEST, tortuosity, pore size distribution, porosity

Session Title: How to Improve Battery Performance by Digitally Optimizing the Microstructure of the Electrodes

Session #: 1-3

Room #: 26C

Abstract:

Improving battery materials is a challenge. The desired properties are not independent and sometimes, even conflicting. For example, a material well suited for fast charging does not necessarily provide a high capacity. Recent advances in imaging techniques, such as x-ray tomographic (CT) microscopy and focused-ion beam scanning electron microscope (FIB-SEM) tomography, provide access to inspecting the porous microstructure of electrodes. Consequently, the importance of the microstructure in influencing the performance of the battery has become increasingly evident. [e.g. M. Ebner, D.-W. Chung, R. E. Garcia, and V. Wood. “Tortuosity Anisotropy in Lithium-Ion Battery Electrodes,” Advanced Energy Materials,4, 1614 (2014)]. Unfortunately, experiments aimed at improving electrode materials on the microstructural level are complex and time consuming. The commonly available battery simulation tools concentrate neither on the microstructural level or on the cell-level. Therefore, they fail to provide crucial feedback on possible cell-level improvements attributable to modifications on the microstructure. The GeoDict software will be used to establish a link from the representative volume element of the electrode material to the macroscopic cell performance. We will conduct an illustrative workflow in GeoDict, starting with a FIB-SEM scan of a cathode material, which will be used to create a 3d-model of the material with GeoDict. This 3d-model will be digitally cloned to create its virtual twin. The performance of the virtual twin will be tested at the cell-level. Here, we will use an integration of BEST (Battery and Electrochemistry Stimulation Tool) into the GeoDict software to determine characteristic properties of the cell, such as life-time, possible charge rates etc. Based on the results, we will start an optimization loop for the microstructure and, at the end, digitally design the next generation cathode material. The use of the GeoDict software for battery simulation cuts down the steep learning curve of standard battery simulation software before the user obtains valuable simulation results. Its user-friendliness also empowers non-experts and beginners in simulation to use it in their battery research. The proposed use of this simple-to-operate simulation software allows everyone to examine and improve battery materials fast and efficiently.

Presenter Name: Glickstein, James

Presenter Company: GrafTech International Holdings Inc.

Presentation Title: Modeling the Impact of Joint Design on the Mechanical Performance of Graphite Electrode Columns (J. Glickstein, GrafTech International Holdings Inc.; Lvl: 2)

Type: Presentation

Keywords: Graphite, Carbon, Electrode, Steel, Contact, Electric Arc Furnace, Structural, Design, COMSOL

Session Title: Contact, Joints, Welds & Connections 2

Session #: 1-2

Room #: 25C

Abstract:

Graphite electrodes as large as 30 inches in diameter and weighing over one thousand pounds are assembled into columns for use by electric arc furnace (EAF) steel producers to melt and refine scrap steel. GrafTech International is a manufacturer of these graphite electrodes that must withstand mechanical forces on the order of 10 kN, electric currents on the order of 100 kA, and temperatures approaching half that of the surface of the sun. Due to the large size/expense of the product, lengthy production times, and extreme environments in application, product improvement through physical testing is a significant challenge. GrafTech has developed multiscale and multiphysics finite element models to more rapidly predict the performance of various product designs in application. A critical performance metric for graphite electrodes is the strength of the joint connecting the top two electrodes in the column, which experience high stresses from bending forces produced by impacts with large scrap pieces. Prior investigations into the bending strength of graphite electrode joints have generally been through physical testing, the conclusions from which have been limited by variability in machined dimensions, the stochastic strength response of coarse-grained graphite, and the high cost required for repeated testing. In this work, a three dimensional structural mechanics model was developed with contact physics applied along fully defined mating threads at the joint interface. A bending load was applied to the bottom of the simulated column geometry to predict the peak bending stress magnitudes and locations for a variety of inputs. Two fundamental approaches to electrode jointing, ‘pin’ and ‘pinless’ systems, were evaluated using this model. In the ‘pin’ joint design, a threaded socket is machined into each electrode end and a connecting pin is used to join the electrodes into a column. In the ‘pinless’ joint design, a threaded socket is machined into one end of the electrode and a threaded tang is machined into the other end; the joint is formed by screwing the tang of one electrode into the socket of the joining electrode. The model has been used to evaluate the impact of joint design, bending load, and material properties on the predicted stress magnitudes and locations. Given the quasi-brittle nature of graphite, both tensile and shear stress failure criteria are examined. Predicted locations of failure are compared to real-world observed failure mechanisms. The relative performance of ‘pin’ and ‘pinless’ designs are compared to past physical testing and are used to provide quantitative benchmarks to customers. The model can be adjusted to match the operating conditions of specific customer furnaces to give recommendations for product selection. The results produced by the model developed in this work represent a significant advancement in understanding the effects of various variations in the joint design on the resultant bending stresses, and the model continues to be used by GrafTech to motivate product design and improve product performance.

Presenter Name: Godoy, Francisco

Presenter Company: Engineering Systems Inc. (ESI)

Presentation Title: Frictional Forces in Oils Well Casing Strings by Using FEA (F. Godoy, Engineering Systems Inc. (ESI); Lvl: 2)

Type: Presentation

Keywords: 3D FEA analysis, Normal Forces, Frictional Forces, Well Casing, Wellhead,

Session Title: Structural Analysis 2

Session #: 1-2

Room #: 26B

Abstract:

During the normal bore drilling process in deep onshore and offshore oil and gas wells no straight runs are achieved and drag forces is one of the main problems when running casing thorough the different casing strings down the hole. Once the conductor casing at the wellhead is placed and the surface casing is installed the subsequent well boring continues and smaller diameter casing strings will be run/installed as different depths until the final depth of the well is achieved. Inner casing strings have to run inside an annular casing which might not be totally straight, in which case the inner casing could find frictional forces due to contacts on the bends down the hole. This analysis can predict what those potential frictional forces would be; based on the normal forces that an inner casing string would have throughout the non-straight path of the outer casing. In this paper a simple method using FEA, by using Abaqus software, is developed in order to predict the level of those normal forces due to the contact of the installed casing down the hole. This method performs the calculation of normal forces exerted by a piping string; as it was deformed into a similar shape to that of the outer casing. For simulating the deformation of the outer casing pipe ring sections are used at the bends and turns (change in angle) of the actual outer casing and then are displaced to duplicate the outer casing overall shape down the hole. Verification of the numerical analysis results are carried out by field testing's at the ESI facility. An artifact was fabricated to produce bends and turns on an outer/inner pipe string assembly and then to measure the frictional force required to slide the inner pipe for different deformations of the casing. The results of this paper corroborated that the method developed with ABAQUS FEA procedures would yield precise calculations of the casing frictional forces for both onshore and offshore oil wells.

Presenter Name: Goodin, Mark

Presenter Company: SimuTech Group

Presentation Title: Using Computational Fluid Dynamics to Predict the Effects of a Mandibular Repositioning Device on the Airway of Patients with Obstructive Sleep Apnea (M. Goodin, SimuTech Group; Lvl: 2)

Type: Presentation

Keywords: Sleep Apnea, Computational Fluid Dynamics, Mandibular Repositioning Device

Session Title: Medical Devices 2

Session #: 2-3

Room #: 26B

Abstract:

M. Goodin1, M. Showalter1, A. Tran2, R. Gupta, DDS, MD, MBA2,3, R. Silva, DMD, FACD2,3, S. Connelly DDS, MD, PhD, FACS2.3 1SimuTech Group, Inc., Hudson, OH 2University of California, San Francisco, CA 3San Francisco VA Medical Center, San Francisco, CA Purpose Obstructive sleep apnea (OSA) is a serious medical condition that has considerable health and social consequences. OSA occurs as a person enters sleep and the muscles in the throat relax leading to localized airway collapse. Mandibular repositioning devices (MRD) are an effective, non-invasive treatment option for patients with OSA. The current study uses computational fluid dynamics (CFD) to predict the flow through airways of patients with OSA, both with and without a MRD. The goal being to identify flow and anatomy-related parameters that best correlate the CFD predictions with patient outcomes. Methods The severity of OSA is diagnosed using a polysomnography (PSG) test conducted and was analyzed at the San Francisco Veterans Affairs Medical Center (SFVA) Sleep Center. Based on the severity, patients were selected to have a custom MRD fabricated. For these patients, a repeat PSG with the MRD in place was obtained. These patients also underwent a CT scan with and without the MRD. Three-dimensional models of the airways were reconstructed from the CT scans using MIMICS software (Materialise, Ann Arbor, MI). Steady state CFD simulations using ANSYS-CFX (ANSYS Inc, Canonsburg, PA) at a near peak inhalation air flow rate of 300 ml/sec were used for this study. Airway compliance was not included in these simulations. Results For this pilot study, a total of eight patients were treated with a MRD. Based upon their PSG results, each patient showed improvement in OSA severity as measured by their change in apnea-hypopnea index. The CFD results focused on the predicting the flow through the soft palate and behind the epiglottis. These are the two airway locations that typically exhibit the smallest opening size and therefore greatest likelihood of airway collapse. Key parameters studied included the local flow areas, anterior & posterior clearances, peak airway velocity, overall airway resistance, and minimum static pressures along the back of the airways. For five of the patients, these key parameters all showed consistent improvement with the MRD. The key parameters trended in opposite directions for the other three patients. Conclusions The CFD results predicted improvement using a MRD for five of the eight patients studied. For the patients with predicted improvement, the increase in flow area near the soft palate was dramatic, particularly in the lateral dimension. Such information was made clearer when viewing the three-dimensional airway reconstructions. The CFD results provide quantitative information concerning the change in local flow velocities and static pressures along the airway. A lower static pressure and narrower airway suggesting an increased likelihood of airway collapse. An interesting observation, for the three patients where the CFD modeling and PSG testing disagreed, is the amount of mandible advancement was near the upper range for this group of patients. Our future focus is on expanding the patient database and looking more closely at the anatomical changes and variability in patient CT scans with use of a MRD.

Presenter Name: Goodin, Mark

Presenter Company: SimuTech Group

Presentation Title: Total Artificial Heart Computational Fluid Dynamics Modeling - Gaining Insight to Reduce the Potential for Thrombus Formation (M. Goodin, SimuTech Group; Lvl: 2)

Type: Presentation

Keywords: CFD, Thrombus, Total Artificial Heart, Blood Pump

Session Title: Medical Devices 3

Session #: 3-1

Room #: 26B

Abstract:

Mark S. Goodin, MSME1, David J. Horvath, MSME2, Nicole Byram, BS3, Jamshid H. Karimov, MD, PhD3, Shinji Okano, MD3, Gengo Sunagawa, MD3, Takuma Miyamoto, MD3, Kiyotaka Fukamachi, MD, PhD3; 1SimuTech Group, Hudson, OH, 2R1 Engineering, LLC, Euclid, OH, 3Cleveland Clinic, Cleveland, OH. Purpose A series of four chronic animal studies was performed with Cleveland Clinic's continuous-flow total artificial heart (CFTAH), without administration of postoperative anticoagulation. Upon explant, the blood flow paths for the pumps were clean except for varying amounts of thrombus attached to the right pump impeller. The current work focuses on using computational fluid dynamics (CFD) to identify an improved right impeller design that could reduce the potential for thrombus formation. Methods Transient, rotor-stator CFD (CFX, ANSYS Inc., Canonsburg, PA) analyses of the CFTAH were performed. The flow patterns near the left impeller surface, which was thrombus free, were used to gain insight into the desired flow patterns for different right impeller designs. Several right impeller design variations were evaluated including changes to the inlet design, impeller cone angle, and the blade shape. A non-Newtonian blood viscosity was used for the simulations. The key flow-related parameters evaluated included an Eulerian platelet stress accumulation (PSA) model, inward radial flow patterns, impeller shear stress, and flow residence time/local shear stress on surfaces just offset from the impeller were used to compare the different impeller designs. Results The CFD results for the right impeller designs modeled revealed similar trends in the flow patterns with flow recirculation commonly occurring on the suction side of the right impeller blades. These recirculation regions corresponded well with the thrombus seen along the suction side of the impeller blades for the explanted pumps. For one explanted pump, a star-shaped thrombus formed around the impellers which was consistent with the areas of increased residence time/local shear stress. Iso-volumes of relative inward radial velocity also revealed regions of flow recirculation near the trailing edges of the impeller blades. Conclusions The CFD simulations revealed flow separation off the leading edge of the impeller blades and flow wrapping over the trailing edges of the impeller blades. Both effects causing flow recirculation on the suction side of the impeller blades. These flow separation effects were not seen around the left pump impeller. The right pump impeller flow is constrained by a cylindrical housing and a narrow flow aperture through which the flow passes to reach the right pump outlet. The aperture is used to balance the left/right pump flows and pressures. In comparison, the flow from the left impeller passes directly into the left pump volute and outlet port. We have recently identified a potentially improved design that showed reduced regions of flow recirculation and is undergoing further evaluation.

Presenter Name: Grimberg, Patrick

Presenter Company: Digital Product Simulation

Presentation Title: Leverage Aircraft Structures Design with Engineering Collaboration (P. Grimberg, Digital Product Simulation; Lvl: 2)

Type: Presentation

Keywords: Engineering, Collaboration, Simulation, Design, Knowledge, Parameter, Rule, Tool-agnostic

Session Title: Simulation Governance: Data Management 1

Session #: 2-1

Room #: 24

Abstract:

Aerospace industry is driven by weight constraints and structures lightening to ensure better performances and higher fuel economies, ultimately providing a greater flying experience to customers. This paper will focus on a project aiming to expand an aircraft flight's duration. To answer this issue, additional tanks need to be added to the aircraft structure. This modification impacts the overall aircraft lifecycle from pre-concept architecture design to maintenance phases. To reduce certification risks and reduce costs, it appears necessary to reuse existing data to better define a reference configuration, common to all actors involved in the project who will then perform trade-off studies starting from it. As a matter of fact, several engineering entities happen to work concurrently. Therefore, they need a solid framework enabling efficient collaborative teamwork. KARREN (Knowledge Acquisition and Reuse for Robust ENgineering) offers an enabling technology that complements all Product Lifecycle Management (PLM), Computer-Aided design (CAD), Computer-Aided Engineering (CAE), and Design Space Exploration (DSE) technologies by providing the ability to capture and reuse engineering knowledge about behavior, enabling collaborations which combine these different areas into a cohesive, coordinated Simulation-Driven Design project. KARREN ensures consistent use of design parameters and rules while enabling knowledge capture and reuse in order to warrant best practices for product performance studies across multiple disciplines for "Behavior Based Collaboration". Throughout this paper, we will demonstrate how different actors, entities, tools and even organizations have been helped to collaborate using KARREN framework all the way through this project. We will particularly focus on how simulation experts utilized KARREN to manage their analysis work, sharing their simulation results both with designers and other analysts to ultimately leverage their technical work throughout the overall project. Finally, we will illustrate configurations that came up from this engineering collaboration and new aircraft structures fulfilling initial objectives and requirements.

Presenter Name: Grimmer, Peter

Presenter Company: Sandia National Labs

Presentation Title: Evaluation of the Nonlinear Mechanical Response in Threaded Fasteners (P. Grimmer, Sandia National Labs; Lvl: 2)

Type: Presentation

Keywords: fastener, reduced order model, plasticity, calibration

Session Title: Reduced Order Modeling

Session #: 3-1

Room #: 26C

Abstract:

The mechanical behavior of complex assemblies depends on the constitutive response of the fasteners joining the components. The modeling of all components and threaded fasteners in detail is often too computationally demanding and rarely practical. Instead, reduced-order models like springs, beam elements, or plugs are commonly used. Linear reduced-order models are usually straightforward and accurate in the elastic regime, but the emergence of plastic deformation creates a strong nonlinear mechanical response. Hence, the accuracy of reduced-order models for threaded fasteners at medium to high strains is dictated by the constitutive behavior of the bulk material. Although the specification of metallic threaded fasteners typically includes alloy grade, manufacturing procedures often work harden the fastener material and increase the uncertainty of the material properties. These effective properties for a given fastener can be obtained by performing fastener tensile tests, but this is a time-consuming process that quickly becomes infeasible as the number of fasteners of interest continues to grow. Hence, an assumed hardening curve must be used to model the plastic response of the fastener. This assumed constitutive behavior will introduce epistemic uncertainty into simulations involving fastened joints. By identifying trends in fastener constitutive behavior the material properties for a fastener model can be more confidently assumed from limited test data. This investigation explores the modeling of fasteners with various sizes by developing finite element models in which material parameters were calibrated to match tension test data on stainless steel A286 fasteners. Sizes ranging from #0 to #6 UNF are considered with two models of varying geometric fidelity: a smooth plug of elements, and a higher-fidelity model including thread geometry. The material calibrations were similar for the plug and the threaded models, consistent with previous findings that the material nonlinearities dominate the tensile response of fasteners. The material model for a smooth annealed steel A286 specimen was calibrated to compare the original material to the fastener material after manufacturing. This investigation reveals that the fasteners have higher yield stresses than the smooth specimen, indicating various degrees of work hardening during manufacturing. This conclusion is extended to the analysis by estimating the fasteners' hardening curves through a shift to the hardening curve of the annealed specimen to match the yield stress, and these curves are compared to independent calibrations of the same fastener. This study indicates that for the fasteners considered, when given the hardening curve of the original material, knowledge of the load versus displacement response of the fastener is unnecessary for calibration; the yield stress of the fastener is the essential piece of information required to estimate its hardening curve. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Presenter Name: Gritter, Luke

Presenter Company: AltaSim Technologies LLC

Presentation Title: Simulation of Electromagnetic Effects in Urban Environment (L. Gritter, AltaSim Technologies LLC; Lvl:)

Type: Presentation

Keywords: Induced currents, bridges, powerlines, safety hazards

Session Title: Electrical 1

Session #: 1-1

Room #: 26C

Abstract:

In today's urban landscape sources of electromagnetic fields (e.g., radio towers and transmission lines) abound and can induce currents in the surrounding infrastructure. Under certain circumstances these can be sufficient to injure or kill humans having contact with these structures. The United States Department of Labor has reported multiple cases of electric shock produced under these conditions but the full number of non-fatal electric shocks due to induced current remains unclear due to underreporting. Computational simulation can be used to identify conditions around fixed urban infrastructure (e.g., bridges and de-energized power lines) that may lead to harmful or fatal electric shock. Recent work conducted on a bridge in Illinois showed that transmission lines passing under the bridge structure produced conditions that led to a non-fatal electric shock for bridge workers. The workers were located on a manlift next to the transmission lines. Previous work showed that an amplitude modulation (AM) radio transmitter located less than one mile from a bridge in New York induced currents of sufficient magnitude to shock bridge workers that were also located on a manlift. The simulations include the source and the structure to assess the interaction. Currents in the bridge and the floating potential of the manlift are both calculated in the analyses. The analyses indicate the conditions leading to electric shock. In addition, a proposed mitigation technique is simulated to demonstrate elimination of the conditions leading to the hazard. To reduce the likelihood of future shock events, simulations of the electromagnetic fields produced by sources such as radio towers and transmission lines can quantify the induced current and floating potential of surrounding structures to identify when conditions exist that could pose a hazard to workers. Thus, the analyses conducted in this work are representative of those that should be conducted when electromagnetic sources are in the vicinity of infrastructure on which work is being performed by humans.

Presenter Name: Helfrich, Reinhard

Presenter Company: INTES GmbH

Presentation Title: Part Design by Simulation (R. Helfrich, INTES GmbH; Lvl: 2)

Type: Presentation

Keywords: Topology optimization, shape optimization, dynamic loading, freeform optimization

Session Title: Product Design Based on Additive Manufacturing 3

Session #: 2-3

Room #: 25B

Abstract:

In the past years, topology optimization and shape optimization have been increasingly established as standard method to support the load path dependent layout of mechanical parts under weight, stress, and durability constraints. Beside the creation of design ideas, users of topology optimization often want to achieve the final design by this type of optimization based on their material and loading definitions without further design work. These requirements lead to a simulation-driven design process, where topology optimization and shape optimization are combined to obtain the desired design. The key point of the design process is a software concept, where all necessary analysis steps and the optimization are integrated in one single software. While topology optimization is often used with static load cases, special focus is put here on dynamic loading. However, studies have shown that the optimal layout under dynamic loads is considerably different from layouts under static loads. In addition, it is very important to model the boundary conditions of the part to be optimized as realistic as possible. The best way is to bring all connected parts into the model and use reduction methods where possible. Moreover, because topology optimization has limited capabilities to determine the stress distribution in the optimized part, a subsequent shape optimization has to be considered to complete the design process. Because the shape found by topology optimization has a free geometry, a free-form optimization method is the right choice for this task. Both stress and weight optimization are supported by freeform optimization under additional constraints like displacement amplitudes due to harmonic loading. As an industrial example, the paper shows an engine bracket, where starting from the available design space and realistic loading and boundary conditions a topology optimization generates a design. This design is directly used for re-meshing and subsequent shape optimization to optimize weight and endurance related quantities. Analysis, optimization, and result evaluation are performed with an industrial FEA code (PERMAS with VisPER).

Presenter Name: Helfrich, Reinhard

Presenter Company: INTES GmbH

Presentation Title: Robust Design by Optimization under Reliability Constraints (R. Helfrich, INTES GmbH; Lvl: 1)

Type: Presentation

Keywords: Robust design, optimization, reliability analysis, uncertain parameters

Session Title: Optimization 3

Session #: 3-2

Room #: 26A

Abstract:

A robust design can be characterized by low sensitivities due to parameter changes, where the changes are small and typically within the tolerances of the design parameters. For designs with high safety factors, robustness is often postulated and not studied in detail. But robustness is becoming very important, when optimization is used to widely exploit the material and safety factors are drastically reduced. Then, small parameter changes can have a significant influence on the results and failures become more likely. So, with the wider use of design optimization, robustness of designs has to be considered more systematically than in the past. From a methodological point of view, optimization and reliability methods have to be available for robust design simulations. Beyond that, the key point is the integration of both methods, i.e. the use of reliability constraints in optimization methods, to directly achieve a robust optimum. From the parameter point of view, there are design variables for the optimization, and there are basic (uncertain) variables for the reliability analysis. A design variable may be uncertain or not. The selection of design variables depends on possible design variations like material, element properties (e.g. shell thickness, beam cross section), and geometry. The selection of uncertain variables depends on tolerance specifications and manufacturing conditions, which influence the product properties. The right ranges and distributions of uncertain variables need additional model input, which best should be obtained from product and manufacturing quality measurements. In addition, also load factors and load directions can be uncertain. As an industrial example, the paper shows a charge air cooler, where an optimization is performed to reduce weight and stresses. Then, uncertain parameters are introduced and failure modes are defined. Their influence on the optimized design is studied and sensitivities are evaluated. Finally, an integrated optimization with reliability constraints is applied to directly achieve a robust optimum. Analysis, optimization, and reliability are performed with the industrial FEA code PERMAS.

Presenter Name: Heller, Marian

Presenter Company: ASME

Presentation Title: Modeling and Simulation/Verification & Validation in Advanced Manufacturing (M. Heller, ASME; Lvl: 1)

Type: Presentation

Keywords: Uncertainty Quantification, Validation & Verification, Advancing Manufacturing Processes & Additive Manufacturing

Session Title: Simulation Governance: Uncertainty Quantification

Session #: 3-1

Room #: 24

Abstract:

ASME's standards and certification has a number of Advanced/Additive Manufacturing initiatives incorporating modeling and simulation or verification and validation, including (a) Y14.46 Subcommittee on Product Definition for Additive Manufacturing, (b) Y14.41.1 Subcommittee on 3D Model Data Organization Schema and (c) V&V-50 Subcommittee on Verification and Validation of Computational Modeling for Advanced Manufacturing. The Y14.46 subcommittee aims to create standardization of dimensioning and tolerancing methods, systems, and indications on engineering product definition digital data sets for additive manufacturing, which will promote uniform practices and will facilitate a common interpretation of these requirements. The Y14.46 standard will supplement the requirements of Y14.5 for additive manufacturing designs. The Y14.41.1 subcommittee aims to create a standard that establishes a schema for organizing information in a model within a digital product definition data set. The schema will define a common practice to improve design productivity and to deliver consistent data content and structure to consumers of the data. The V&V-50 subcommittee aims to provide procedures for verification, validation, and uncertainty quantification in modeling and computational simulation for advanced manufacturing. The subcommittee consists of five working groups, including VVUQ Applications in Process Technologies, which encompasses additive manufacturing. Their objective is to develop and establish best practices for VVUQ in advanced manufacturing, concentrating on multi-step process and system level. Two use cases are proposed, including one in additive manufacturing, starting from a simple case and existing data, and including both physics-based and data-driven models. Each subcommittee and board conducts two to three In-Person meetings a year, complemented by extensive virtual collaboration. In addition to standards development efforts, each group engages in other activities such as the V&V Symposium, workshops, and presentations at peer conferences. This presentation will provide a high-level overview of the work of the various subcommittees.

Presenter Name: Hiremath, Prashant

Presenter Company: Altair Engineering, Inc

Presentation Title: Topology Optimization and Casting Feasibility of a Robot Arm (P. Hiremath, Altair Engineering, Inc; Lvl: 2)

Type: Presentation

Keywords: Topology, Optimization, Manufacturibility Constraints, Casting Simulation, Inspire®, Click2Cast®, Weight Savings, Validation

Session Title: Optimization 4

Session #: 3-3

Room #: 26A

Abstract:

Oftentimes, in the design of a casting, sub-optimal structural concepts are developed which at the same time are not castable, requiring multiple and time-consuming design iterations. This paper describes a process to generate both structurally efficient and also castable parts, while reducing the overall design cycle time. The optimal structure is determined by topology optimization, reducing component mass while maintaining performance requirements. This step is followed by a design smoothing operation and then by a casting simulation to check for casting defects. To demonstrate this software driven product design and process validation, solidThinking Inspire® is used to develop the concept design and Click2Cast® for casting process validation. For the case study reported in this paper, a robot arm is considered. Concept level optimization is carried out with real field loads & manufacturing constraints. Several optimization studies are performed considering different manufacturing options and the final design selected meeting all performance targets. This final design is analyzed to investigate the casting process and any potential defects during manufacturing. To start with the study the existing design of the robot arm is analyzed to find its performance. Further a package space is created around the existing design, considering the surrounding components. Further topology optimization is performed with the objective of Maximize stiffness with constraints on the volume, multiple concepts are generated just by changing the manufacturing constraints i.e. single draw, single draw with no-hole, split draw, extrusion and one with no manufacturing constraints at all. All these concepts are studied and it was found that the concept with no manufacturing constraints was the best, but as it was not manufacture-able the next best concept i.e split draw was selected for further study. This concept was further validated to check the stresses and displacements, it was observed that the new design was 46% lighter with the performance being equal to the existing design. Further design smoothing operation called PolyNurbs were created, which helped in getting a clean geometry. This geometry was taken into Click2Cast and casting feasibility analysis was carried out to evaluate the filling and Solidification process. The initial iteration showed that there was some turbulence being introduced as the selected gate location was not appropriate, also the filling time used i.e. 5 seconds, was very high. So another iteration was performed by moving the gate location slightly in the X direction and the filling time changed to 2.5 seconds. The results from this iteration were quite improved, flow was observed to be very smooth by looking at the velocity plots, the temperatures plot had a uniform distribution, shrinkage porosity observed was 7.5 mm3 which was very low, the percentage porosity was also checked which was very low as well. In this study, a design methodology is presented using an upfront design optimization and casting process simulation to reduce design cycle time and significant cost. The software used are intuitive and well-suited for product designers. Also the seamless modelling environment with finite element solver, optimization engine, and a high performance compute cluster makes it possible to run multiple design iterations very quickly.

Presenter Name: Holland, Frederic

Presenter Company: NASA Glenn Research Center

Presentation Title: An Efficient Database Schema for Capturing Stochastic Material Performance Data Using Probability Distribution Models (F. Holland, NASA Glenn Research Center; Lvl: 1)

Type: Presentation

Keywords: database, statistics, probability distribution, materials

Session Title: Simulation Governance: Data Management 2

Session #: 2-2

Room #: 24

Abstract:

An online materials database is being developed at the NASA Glenn Research Center (GRC) to capture material property information obtained from in-house laboratory tests, helping to eliminate the risk of lost data and to prevent unnecessary duplication of tests. This database uses the GRANTA MI (Material Intelligence) software system. This software is built specifically to handle the peculiarities of materials information. It creates a single corporate information resource, capturing and enriching data from in-house testing and design, proprietary sources, and external references. Tools are also available to analyze and maintain this data and to certify and publish approved information in a secure and controlled manner. With this database users can store, search for, and view images, PDF and Word documents, spreadsheets, movies, and audio along with numbers and text. Every item of materials data, from property values, through spreadsheets containing rolled-up test data, to photomicrographs of materials microstructures can be captured and held in one place. This data is integrated with specialized analysis tools that study tensile, compression, creep, fatigue, fracture toughness, and other properties. Recognizing that material property data is truly statistical in nature, an effort was begun at NASA GRC add the capability to capture stochastic test results or more specifically, the results of the probabilistic analysis of statistical data. In this way, stochastic material property data is then provided in the form of the estimated parameters of the theoretical probability distributions that best model the test data. The probabilistic model parameters, in theory, completely describe the statistical behavior of the material property, i.e., how the variable is distributed. This is in contrast to simple summary statistics (mean, standard deviation, range, etc.) which do not define the distribution. However, the issue arose as how to minimize the number of database attributes required to handle the large number of available probability models, each of which has their own unique parameters. This problem is compounded by the large number of different material properties that would need to be modeled by any one of a large variety of distributions. This presentation illustrates the schema that NASA Glenn uses to capture probabilistic parametric data in an efficient way. As an example, the results of the probabilistic analyses of statistical data from various mechanical tests on the polymer matrix composite material, MTM45-1/CF7442A-36% RW is shown as it is captured in this proposed database schema.

Presenter Name: Hood, Tim

Presenter Company: Superior Industries

Presentation Title: Implementing Rules-Based Simulation Automation for Democratizing Automotive Wheel Design – The Goals, Challenges and Successes (T. Hood, Superior Industries; Lvl:)

Type: Presentation

Keywords: Democratization of Simulation, Simulation Governance, Simulation Driven Design, SPDM, Simulation Automation, CAD/CAE Integration, Non-Experts Accessing Simulation

Session Title: Democratization 3

Session #: 2-1

Room #: 23

Abstract:

Superior Industries is a global automotive supplier dedicated to the design and manufacturing of automotive wheels. With manufacturing facilities in North America and Europe, Superior is the second largest aluminum wheel supplier in the world. Superior uses general-purpose CAD-based simulation tools for the analysis and design of their products. These general –purpose tools are utilized by all of Design Engineers during the development phase of the wheel. Superior also has a dedicated CAE Group that focuses on specialized analysis methods which are necessary to validate and optimize the wheel designs. The Superior CAE Group consists of 10 engineers who have specialized skills in a wide variety of FEA methods, including many advanced non-linear methods. This CAE team creates very high fidelity FEA meshes to discretize the underlying CAD geometry. Because of highly-stylized details in the A-surface geometry on the face of the wheel and small cast-in details that can act as stress risers, meshes created at Superior in the CAE Group must follow a rigorous set of rules. There is a balance between the size of the mesh, potential error created by the mesh size, and the solving time required to maintain project throughput. The desire is to substantially automate the meshing process in order to free time for the CAE experts to spend more time analyzing simulation results. Improved wheel designs are developed when the CAE team has increased time to solve problems rather than creating FEA meshes. Over the last year, senior engineers at Superior have been working with the implementation team at Comet Solutions to develop and deploy a simulation automation template to significantly improve the efficiency of the wheel design and analysis process. The initial implementation and deployment of the finite element analysis automation template has demonstrated the efficiency of this approach for wheel analysis. With the traditional manual approach, the expert analysts at Superior would take 4-8 hours to create a finite element model for analysis, with the potential errors that are generated in a manual process. Wheel geometry is highly complex, and the emphasis on accurate stresses requires adherence to a lengthy set of detailed meshing rules and conventions. Also, there are a large number of complex loading conditions that the wheel designs are subjected to. With the new approach, engineers in the CAE Group can create an accurate model ready for analysis in less than 30 minutes, starting from a new raw wheel CAD model. This has been transformational. The authors will describe the challenges that were faced during the implementation of the template, the extensive and careful validation process, and the successes that were achieved.

Presenter Name: Horsfall, Ben

Presenter Company: BVT Engineering Professional Services

Presentation Title: Traditional Compliance - A Barrier to Efficiency in Construction (B. Horsfall, BVT Engineering Professional Services; Lvl: 1)

Type: Presentation

Keywords: Efficiency, Compliance, Construction, Wind Loading, CFD, Structure

Session Title: CFD 1

Session #: 1-1

Room #: 26A

Abstract:

Regulatory compliance is of grave importance throughout the world, but many processes used to meet standards in construction do not facilitate the use of modern technologies. While they are put in place to ensure public safety, in reality they represent a high risk of human error that can be reduced through technology. The construction industry is still struggling to embrace the technological step-change required to achieve true efficiency. This presentation demonstrates the improvements in accuracy and speed which can be achieved by changing to a computational method to assess wind-building interaction in construction. This method is well understood and documented thanks to the aerospace and energy sectors, so why aren't we using it for building design? A key part of the puzzle is the traditional compliance process. In New Zealand, building design is done in line with building code section B1 (structure) legislation, equivalent to the various construction laws across the States. Taking the example of assessing wind loading, B1 references loading and design standards which involves first consulting AS/NZS 1170.0 for load combinations, then working through AS/NZS 1170.2* to obtain wind loading on the required area of the building. This process is repeated for all areas of concern and the assumptions and estimates used can be significant sources of error. The workflow itself is also riddled with scope for error carryover from one section to the next. So why aren't we leveraging the technology available to us? The answer has historically been time and cost, with detailed CFD models sometimes taking weeks to complete and needing highly skilled (and remunerated) individuals to deliver the work. The information and accuracy that can be gained from these models is vast, but something faster and more user friendly is required to compete with the standards-based approach. Luckily, tools are becoming available which reduce the complexity of CFD modelling for the user, and allow instant yet accurate building pressures to be computed in as much time as it takes to model a block. The scope can then be focused to individual cladding elements, or even expanded to whole cities... * The 1170.X suite of standards can be considered equivalent to ASCE 7/IBC

Presenter Name: Hosseini, Seyedhadi

Presenter Company: Stanford University

Presentation Title: Finite Element Modeling as a Computational Approach to Study Biomechanics of Short Bowel Syndrome (S. Hosseini, Stanford University; Lvl: 2)

Type: Presentation

Keywords: Finite element Analysis, Biomechanics, Growth and remodeling, Short Bowel Syndrome, Bioengineering

Session Title: Biomechanics

Session #: 2-1

Room #: 26B

Abstract:

Finite Element Modeling as a Computational Approach to Study Biomechanics of Short Bowel Syndrome Hadi S. Hosseini, James C. Y. Dunn Intestinal failure (IF) is a rare multifactorial clinical condition that results in patients' inability to sustain normal growth and nutritional and hydration status. Short bowel syndrome (SBS) is the most common cause of IF which is a devastating condition owing to loss of significant intestinal length thereby affecting the organ's ability to absorb nutrients. Current treatment strategies for SBS involve parenteral nutrition and small bowel transplantation; various transit slowing and bowel lengthening procedures have been employed in highly selected subpopulations [1]. However, these therapies have shown limited success and are associated with high rates of sepsis, intestinal failure-associated liver disease, and mortality [1]. Intestinal lengthening by distraction enterogenesis from use of mechanical forces has been studied as a potential treatment for SBS. [2]. Previous studies in our lab have shown successful lengthening of jejunum using Self expanding springs intestines in rats and pigs for both metal and biodegradable springs [3,4]. However, mechanisms that generate lengthening remains poorly understood from a biomechanical perspective. Main aim of this study was to determine the mechanism behind intestine lengthening as well as optimizing spring design and characterization to have maximum intestine lengthening using finite element modeling. The mechanics of lengthening as well as correlation of stress experienced by tissue and tissue growth were tested with finite element models. Three-dimensional models were created using ABAQUS FEA (D. S. Simulia). Initial geometry was matched to real pictures which was a hollow cylinder (including several tissue layers), while nonlinear material properties were taken. At the first step by applying same spring force to the geometry, model could predict consistent values for tissue lengthening and other geometrical measurements compare to experimental data. Then using UMAT subroutine as described by Young et al. [5], stress-dependent growth was implemented in the models to investigate role of stress in intestinal tissue behavior (lengthening, tube expansion and thickening of tissue) where stress experienced by tissue because of spring force triggers tissue response to the mechanical force. At the tissue level growth can be simulated using theory of Rodriguez et al [6], The total deformation is described by the deformation gradient tensor F, which can be decomposed as F=F^*.G where G is the growth tensor and F* is the elastic deformation gradient tensor. The growth tensor defines the stress-free configuration for each material element after it grows. With computational models we saw how the geometry of the intestine change over time as well as the model supports this hypothesis that mechanical force can play an important role in intestinal lengthening two steps. First by stretching the tissue directly and in second step by turning on the tissue response to the stress and triggering growth. However future work will include additional complications for the further investigations. References [1]. Thompson JS, et al. Current management of the short bowel syndrome. Surg Clin North Am. 2011; 91(3):493-510. [2]. Sullins VF, et al. Function of mechanically lengthened jejunum after restoration into continuity. J Pediatr Surg 2014; 49:971–5. [3]. Scott A, et al. Repeated mechanical lengthening of intestinal segments in a novel model. J Pediatr Surg 2015; 50:954–7. [4]. Sullins VF, et al. A novel biodegradable device for intestinal lengthening. J Pediatr Surg 2014; 49:109–13. [5]. Young J. M., et al. Automatic generation of user material subroutines for biomechanical growth analysis. ASME J. Biomech. Eng. 2010; 132: 104505. [6]. Rodriguez, E. K., et al. Stress-dependent finite growth in soft elastic tissues. J. Biomech. 1994; 27: 455-467.

Presenter Name: Hsu, Yu-Ting

Presenter Company: Carnegie Mellon University

Presentation Title: Large-Scale, HPC of Local Electrochemistry in Solid Oxide Fuel Cell Microstructures Based on Morphology-Preserving Meshes (Y. Hsu, Carnegie Mellon University; Lvl: 2)

Type: Presentation

Keywords: SOFC, Finite Element, Microstructure, Simpleware, ScanIP, MOOSE, High Performance

Session Title: Multiscale

Session #: 1-1

Room #: 21

Abstract:

Recent progress in micro-scale three-dimensional (3D) characterization techniques, such as Focused Ion Beam - Scanning Electron Microscopy (FIB-SEM) and X-ray nanotomography, has brought new ways to relate material microstructure to performance/properties. Such techniques have become increasingly common for studying solid oxide fuel cell (SOFC) microstructures. Most reported reconstructions have been based on in-house cells made in controlled laboratory settings, which have been argued to have uniform, or homogeneous, microstructures. Electrochemistry models based on these average or uniform microstructures have produced good agreement for the average performance of cells from which the reconstructions were made. Nevertheless, unacceptably high degradation rates inhibit widespread commercialization of SOFCs. It is possible that degradation is more closely related to the specific internal distribution of the 3D microstructural features, rather than the mean values from a given volume. Furthermore, commercial cells, or cells manufactured in large-scale assembly lines, have shown substantially less microstructural uniformity than that reported for in-house cells. These microstructures exhibit local phase heterogeneities across many different length scales, from microns to tens of microns and more, and they are correlated to tails or outliers of distributions in transport/electrochemical properties. Thus, it is critical to study such commercial microstructures with dimensions large enough so that full distributions of performance metrics can be generated. This work aims to quantify local distributions of transport/electrochemical properties in commercial SOFC microstructures over large length scales that can populate a significant number of outliers. An emphasis is placed on the workflow to scan, mesh, and model complex SOFC microstructures over tens of microns and beyond using the Finite Element (FE) method. Specifically, we use high-resolution (~50 nm point spacing) Xe-plasma FIB-SEM to capture microstructures with dimensions on the order of 100-200 µm. Since local electrochemistry takes place at morphological features that vary throughout microstructure, it is important to retain the morphologies when converting microstructure image data to computational domains (for computing electrochemistry). To this end, we use ScanIP and the FE add-on module in the Simpleware software platform (Synopsys, Inc., Mountain View, CA) to convert the 3D scan image data into microstructural, multi-domain and simulation-ready volumetric FE meshes that preserve surface morphologies in three-phase SOFC electrodes. Finally, we use MOOSE (Idaho National Laboratory) – an open-source FE framework designed for high-performance platforms – to simulate microstructure-based electrochemistry on a supercomputer (Joule, National Energy Technology Laboratory). Avoiding singularities at triple lines motivated converting the latter to small volumetric features (50-100 nm) so that reactions between the phases – as well as transport along the lines – can be defined. Preliminary results regarding distributions of local electrochemical parameters throughout large-scale microstructures will be presented using data analytics and statistical sampling techniques.

Presenter Name: Huang, Joshua

Presenter Company: Exco Engineering

Presentation Title: Simplified Modeling for Thermal Stress Analysis of Conformal Cooling Line in Die Casting Die (J. Huang, Exco Engineering; Lvl: 2)

Type: Presentation

Keywords: conformal cooling, thermal stress, die casting process, FEA, cooling line design, additive manufacturing

Session Title: Product Design Based on Additive Manufacturing 1

Session #: 2-1

Room #: 25B

Abstract:

With the development of additive manufacturing technology conformal cooling application has been gaining popularity in die casting manufacturing process, because the conformal cooling can make significant improvements to both quality and productivity, and plus cost reduction. However, there is no existing effective and efficient methodology for the conformal cooling design for die casting manufacturing process, which can take the thermal stress into account to maximize the cooling efficiency of the conformal cooling. A full thermal-mechanical structural stress analysis of the conformal cooling line in the die casting manufacturing process is very complex and time consuming, which requires both CFD/FEA expertise and deep die casting process knowledge. As a result, most design practices in die casting industry are based on experience-guess-trial approach, which results in either not fully maximizing the cooling efficiency or cracking the insert prematurely. In order to take full advantage of conformal cooling line there is an urgent need for a simplified efficient methodology to analyze the thermal stress of conformal cooling line in die casting manufacturing process. This paper presents a simplified modeling approach to analyze the thermal stress associated with conformal cooling line in die casting die by introducing a standard thermal load from molten metal on a hot zone and using local substructure to reduce the modeling scale and numerical complexity. The standard thermal load is a conservative estimate based on the fact that the solidification time of a hot zone is normally longer than the time required for the local insert in the vicinity of the cooling line to achieve quasi-steady thermal equilibrium, the temperature range of molten metal is narrow at the early solidification phase due to the latent heat effect and the maximum thermal hoop stress of a cooling hole can be achieved as a steady state thermal condition is met. The local substructure model is assigned with proper thermal and mechanical boundary conditions and can be considered as a sub-structural FEA model, which is based on the knowledge gained from the whole die casting die assembly FEA. Numerical results of the simplified modeling were compared with the results of the full complete die assembly stress analysis. The difference between these two types of analyses is minimal and acceptable both in the magnitude of the maximum thermal stress and the stress distribution of the cooling line in the die insert. With this simplified approach thermal stress analysis of conformal cooling line can be done with simple FEA software that has basic steady-state thermal and static structural analysis functions. It makes a large number of numerical investigations possible, allowing exploration of the thermal stress trend associated with cooling line design parameters and gaining a better understanding of cooling line possible failure mechanisms in different scenarios. This approach provides design engineers the ability to evaluate initial design parameters quickly and increase first design success rate.

Presenter Name: Hunter, Tim G.

Presenter Company: Wolf Star Technologies

Presentation Title: Two-Wheeled Scooter Dynamics: Strains and Load Reconstruction (T. Hunter, Wolf Star Technologies; Lvl:)

Type: Workshop

Keywords: Two Wheeled Scooter, Finite Element Analysis, True-Load, Strain, Strain Gauges, Field Loading, Time Series Loading, Influence Coefficients, Load Reconstruction

Session Title: Two-Wheeled Scooter Dynamics: Strains and Load Reconstruction

Session #: 2-2

Room #: 25A

Abstract:

Experienced simulation and test engineers who work on products undergoing complex loading from the environment, customer loading and internal loading know that obtain load time histories that reproduce measured strains from test in the simulation environment is close to impossible. This workshop will demonstrate how to prepare an FEA model and test specimen to perform the full load reconstruction in methodical fashion. The workshop will include live testing and data collection. The demonstration object will be a two wheeled Razor Scooter. Correlation between measured strain and simulated strain from the load reconstruction will be displayed. This course will discuss the broad application of the technology to a large segment of the structural based simulation environment. This technology is one of the enable factors for the successful implantation of Digital Twins.

Presenter Name: Hurlston, Robert

Presenter Company: Caelynx LLC

Presentation Title: Evolution of NuStep Exercise Machine Sickle Design Utilizing Optimization and Additive Manufacturing (R. Hurlston, Caelynx LLC; Lvl:)

Type: Presentation

Keywords: Simulia, Abaqus, Tosca, Optimization, Additive Manufacturing

Session Title: Product Design Based on Additive Manufacturing 1

Session #: 2-1

Room #: 25B

Abstract:

NuStep is a manufacturer of high-end exercise equipment for use in physical therapy, cardiac and stroke and rehabilitation. The design of this type of equipment is challenging, because it must be multifunctional, space efficient and cost competitive. The subject of this case study was a combined recumbent cross-trainer in which the sickle is a key component, responsible for transferring load between the users legs and the eddy current generator, which provides customizable resistance. The key difficulty faced during this type of component design is striking the optimum balance between weight, rotational inertia, or "feel", and load bearing capability. Traditionally, the design (or redesign) of a sickle component like this would demand costly and time consuming parametric type optimization until the required criteria were met. Essentially, the modification of certain design parameters would have to be tackled individually, and results would generally be compiled and compared in order to help drive the design process. However, utilizing state-of-the-art optimization and additive manufacturing processes, an optimal design was found within a matter of days. Tosca, in conjunction with Abaqus, was used to develop a number of studies in which various combinations of design constraints and targets were examined. Importantly, Tosca allows the definition of manufacturing constraints, which, in this case, meant that a castable solution was always achieved. Optimization targets for both rotational inertia and deflection criteria were either met or exceeded. The combined results of these topology optimizations were then mastered into manufacturable CAD and provided to the customer. Prior to full production, NuStep created sand casts via additive manufacturing such that prototype testing could be carried out. NuStep is now utilizing the new design in the continued improvement of the product. Further, Caelynx is working on next generation sickle designs that could take full advantage of metal additive manufacturing for low volume production.

Presenter Name: Illa, Kaushik

Presenter Company: Siemens PLM Software

Presentation Title: Vibro-Acoustic Analysis of a Permanent Magnet Machine for Electrical Vehicles (K. Illa, Siemens PLM Software; Lvl:)

Type: Presentation

Keywords: Noise , Vibration, Electromagnetic Forces, Finite Element, Finite Volume, Boundary Element Method, virtual prototyping, simulation

Session Title: Vibro-Acoustics

Session #: 2-1

Room #: 26A

Abstract:

With the emergence of hybrid vehicles and the significant reductions of combustion engine noise achieved in the past few years, new challenges arise. In particular, electric machines have become a significant contributor to noise in cars. The noise produced by a machine in operation can be assessed early on in the design process using simulation methods (virtual prototyping). In this paper, we present a series of tools chained seamlessly from the electromagnetics inputs to the noise outputs. This paper presents currently available methods for assessment of the noise induced by the magnetic field in a brushless permanent magnet machine. The method combines an original method based on Finite Volumes to get the electromagnetic forces together with Finite Elements to compute the structural response, and a Boundary Element Method to compute the induced noise. Special care is taken on the interfaces between the methods used, both in terms of accuracy and ease of use. This machine was selected, as they tend to generate noise in vehicles, which makes the problem more interesting to solve. The process begins with the geometry creation; this is done in the software SPEED, using either templates or an embedded CAD modeler. This is where the control parameters are defined for example, the current, the voltage, the circuit regulation topology, phase advance angles and other parameters which are essential in defining the electromagnetic characteristics of the machine. The current profile from SPEED is imported into STAR-CCM+ where the objective is to calculate the electro-magnetic surface force distribution, and record their time history in a file that will be read in the vibro-acoustic analysis. In this paper we present a novel approach using a finite volume discretization technique to a 2D section of an electric machine and obtain the magnetic field distribution and electromagnetic force acting on the stator surface of an electric machine. In a second part of the paper a vibro-acoustic analysis is presented where we use Virtual Lab (VL). A coupled structural-acoustic model is created in VL where the geometry and loads are imported to define spatially distributed loads. The procedure is different from those published by other authors who have illustrated the use of numerical methods for similar purposes; however they have some practical limitations. The vibro-acoustic coupling was usually handled using a weak formulation, whereas a strong formulation is better suited to a vaster category of problems (the electric motor may be placed in a thin plastic enclosure, possibly with foams around, for example). In addition from the prior references, the quality of the mapping between the tools required a specific interface, external to the tools used for each sub-task (electromagnetic or vibro-acoustics); this usually meant great care on the user side. In this work we propose an embedded mapping method, more comfortable for industrial usage. The surface loading on the stator uses electromagnetic forces as a source in a fully strong-coupled vibro-acoustic analysis of the stator and housing compounds; the problem is solved using a state of the art FEM-BEM solver. Results include sound pressure level spectra, and informative visualization of the dominant structural modes at the peaks, which opens perspectives for design improvements. A chain of tools will be illustrated using the state-of-the-art methods all part of Siemens Simcenter portfolio. Special care was taken to have a good mapping procedure to ensure a good quality of the final results. The automation of the vibro-acoustics steps enables the use of the tool chain by non-vibroacousticians.

Presenter Name: Jaiswal, Ashish

Presenter Company: John Deere India Pvt Ltd

Presentation Title: A Journey towards "Commoditization" of Simulation and Analysis IT Resources to Support "Democratization" Vision of CAE Users Community (A. Jaiswal, John Deere India Pvt Ltd; Lvl: 3)

Type: Presentation

Keywords: Democratization, open source, Licensing

Session Title: Democratization 2

Session #: 1-2

Room #: 23

Abstract:

"A journey towards "Commoditization" of Simulation and Analysis IT resources to support "Democratization" vision of CAE users community" The role of Simulation and Analysis (S&A) in the product development process (PDP) is of utmost importance. Through tremendous efforts, the computer aided engineering (CAE) community has established S&A for the PDP of critical components, however, the industry's CAE subject matter experts still need to unleash the true value of S&A to the overall PDP. The state that the industry wants to achieve is termed as "democratization" of S&A and will integrate S&A into the PDP by providing simulation tools to the design community. The planned roadmap of this journey to democratization won't be complete without re-visiting the existing CAE software licensing model. We believe to truly achieve this vision of S&A democratization, the passion of the CAE user community and Independent Software Vendors (ISVs) need to go hand in hand to enable "commoditization" of software. With the maturity of high performance computing (HPC) in cloud computing, the hardware providers have already embraced the democratization vision and are driving full throttle with hardware technology advancements. The potential benefits of the hardware commoditization journey, however, are not being realized since progress has been governed by existing licensing models. The CAE user's community has realized the importance of commoditization of S&A resources to support the democratization vision. A step towards that, the businesses have provided CAE teams access to cloud HPC and embarked upon the journey of commoditization of CAE software licenses. We have explored many paths to democratization and in this presentation we will discuss the various options such as Open Source software, partnering with existing key ISVs, and collaboration with universities and research groups. We will also discuss the challenges we have faced and those we are still facing on our journey towards democratization.

Presenter Name: Jarrett, Jeremy

Presenter Company: Kinetic Vision

Presentation Title: Are Virtual and Augmented Reality the Next Mouse and GUI? (J. Jarrett, Kinetic Vision; Lvl: 1)

Type: Presentation

Keywords: augmented reality, virtual reality, ar/vr, virtual tour, virtual product placement, virtual training, virtual design visualization, computer interfaces

Session Title: Virtual/Augmented Reality

Session #: 3-2

Room #: 25A

Abstract:

Virtual and Augmented reality have been hyped as the “future” of how humans will interact with computers, but even though VR/AR technology has been available for nearly a decade, that revolution hasn’t yet occurred. Really not much has changed, with the notable exception of mobile computing, since the development of the mouse and graphical user interface (GUI) over forty years ago. But few people remember that the mouse and GUI also languished in obscurity for over twenty years prior to the mainstream interest that came with the 1984 introduction of the Apple Macintosh desktop computer. Public acceptance and demand finally occurred because of the rise of a “killer” application (desktop publishing), effective marketing by Apple, and porting of successful programs to GUI interfaces. This presentation examines the current state-of-the-art of AR and VR, using actual use cases as examples. Rather than present edited videos or pre-rendered images, these examples will be presented live, with the audience co-experiencing in real time as the presenter navigates the digital environments. Several examples will be presented: • Virtual and augmented product placement • Virtual architectural tours • Virtual training applications • Virtual product design and simulation visualization These examples will demonstrate how VR and AR are creating new ways for people to interact with digital information. Instead of the current use-model where words and images are presented on a flat screen, in the near future information will be cohesively integrated within the user’s virtual environment. This environmental experience will replace the book experience of the last fifty years, creating infinite possibilities for greater understanding, communication and collaboration. So, is 2018 going to be 1984 all over again? Only time will tell for sure, but if these examples are any indication of where AR and VR are headed, the future of computing is here, and our ubiquitous rodent friends are finally headed for the technology junkyard.

Presenter Name: Jatale, Anchal

Presenter Company: ANSYS Inc.

Presentation Title: Using Reduced Order Modeling and Multiphysics Simulation to Predict Product Failures and Develop Smart Preventive Maintenance Programs (A. Jatale, ANSYS Inc.; Lvl: 3)

Type: Presentation

Keywords: Fluids, CFD, Computational Fluid Dynamics, FEA, Systems, Simulation, Reduced Order Modeling, ROM, Multiphysics, Heat Exchanger, ANSYS,

Session Title: Multiphysics 3

Session #: 3-2

Room #: 21

Abstract:

In order to ensure profitability for the entire product life cycle, engineers need to optimize preventive maintenance and downtime. Multi physics simulations have long been used optimize product performance during the initial development but their relatively large investments in time and effort have slowed their use with applications involving predictive maintenance and prognostic health monitoring. Reduced order models (ROMS), coupled with systems simulation show promise to deliver fast, accurate data. For example, full models which took hours on multiple CPUs can now be achieved using ROMS within minutes or even seconds on single CPU. These fast results can be extremely useful to predict the cause, location and even time of failures or turned into performance charts for field operators. We will present heat exchangers as an example. They are commonly used in industrial settings including refineries and chemical plants. Companies spend multimillions of dollars on unscheduled maintenance and shutdown due to heat exchanger failure. We will show examples of how multi physics simulation of various failure modes was used to help determine the cause of the failures, location of failures, even be used for testing failure mitigation methods. Computational fluid dynamics (CFD) modelled fouling and corrosion on heat exchanger surfaces such as tubes, baffles and shell. Effects of operating conditions like inlet flow rates were also shown on the heat transfer characteristics and failure modes. The CFD results (thermal and hydrodynamic loads) were then transferred onto FEA solvers to analyse the fatigue life and buckling of the metal surfaces. These failure modes were then connected to the system level digital plant via the use of Reduced Order Models (ROM) to perform operational optimization. Multiple approaches to create and use ROMs were highlighted in the paper. These ROMs are not just input-output signal type models but complete three dimensional field view models.

Presenter Name: Kaloudis, Alexis

Presenter Company: BETA CAE Deutschland GmbH

Presentation Title: Multidisciplinary Topology and Parametric Optimization of a BiW, Following a Unique Holistic Process (A. Kaloudis, BETA CAE Deutschland GmbH; Lvl:)

Type: Presentation

Keywords: ACP OpDesign, Optimization, 3G Optimization, Parametric optimization

Session Title: Optimization 3

Session #: 3-2

Room #: 26A

Abstract:

The use of Topology Optimization raised even more the data handling‘s and resources‘ needs. On top of these, there is no system available, which is able to combine in a streamlined process and with the aid of a directly connected database, Topology and Parametric Optimization along with manufacturing alternatives. In this presentation, a multidisciplinary topology and parametric optimization of BiW takes place utilizing an intuitive and process guided optimization system, using its own interface. Following step-by-step the various phases of the process, and starting from a product design space, we apply various loads for a topology optimization analysis. The results are interpreted and transformed into a low fidelity model, which is then validated under the same loads. It is then parametrized regarding its geometry (3D shape, position, cross section), its material and thickness, and a parametric optimization takes place. The results of this analysis are post-processed and evaluated taking under consideration also the manufacturing alternatives.

Presenter Name: Karve, Madhura

Presenter Company: Altair Engineering, Inc

Presentation Title: Multidisciplinary Design Optimization of a Winglet (M. Karve, Altair Engineering, Inc; Lvl:)

Type: Presentation

Keywords: Shape optimization, fluid-structure interaction, flutter reduction, winglet design, design of experiments (DOE)

Session Title: Optimization 1

Session #: 1-1

Room #: 22

Abstract:

In this project, the shape of a winglet (mounted on a wing) and the material thickness is changed to reduce the fluttering of the tip. For this the structural solver OptiStruct and the CFD solver AcuSolve are combined to solve a fluid-structure interaction (FSI) together. The FSI is performed with HyperStudy automatically by extracting the eigenfrequencies of the FEM model first, maps them on the CFD mesh and submits the AcuSolve run in the end. HyperStudy is also used for design of experiments and optimization. The two models are prepared in advanced by morphing their shapes in the same way and connect them with HyperStudy. The challenging part of the project is to generate robust models (even with morphed shapes) and robust automations to get the results projected. Another challenge was to optimize the required resources at this was a computationally demanding simulation. Each run took around 10hrs on a 64 core linux machine. First a DOE is ran. Modified Extensible Lattice Sequence (MELS) is used for the DOE method. The results show that the most important design variables are the material thickness, the cant angel and the twist angle. Using this findings the, an optimizations is run with the remaining 5 variables: Thickness, the cant angle, the twist angle, the displacement of the winglet tip in flow direction (perpendicular to the reduced wingtip displacement) and the tip length. HyperStudy evaluated 57 successful runs to find the optimum winglet design that minimizes tip displacement. So, for the optimization the main goal was to reduce the fluttering but a constrain was to decrease the mass around 2kg and the lift-to-drag ratio has to be the same or greater than the baseline design value. Global response surface method (GRSM) is used for the optimization as this is an efficient global search method. The optimum found is 1.1% lighter and decreased the maximum tip displacement around 40%.

Presenter Name: Kashi, Raghav

Presenter Company: Siemens PLM Software

Presentation Title: Enabling Non-expert Users Across the Enterprise to Discover Better Designs, Faster by Automating Design Exploration (R. Kashi, Siemens PLM Software; Lvl: 1)

Type: Presentation

Keywords: Design Space Exploration, Simulation Data and Process Management, SDM, SPDM, SDPM, MDO

Session Title: Simulation Governance: Collaboration 1

Session #: 1-1

Room #: 24

Abstract:

Design Space Exploration tools are becoming increasingly essential in modern product development processes - to automatically explore the design space and quickly identify innovative solutions that meet desired goals, such as reducing product cost and / or mass while improving performance across one or more disciplines/departments. Simulation data and process management (SDPM) systems are –being used to provide complete traceability from product performance requirements to simulation results and reports, to provide a collaborative environment for designers and analysts across the enterprise, to manage and automate simulation tasks and processes etc. This paper focuses on how an SDPM system, enables non-expert users (designers and analysts) across the enterprise to discover better designs, faster by automating design exploration using design space exploration tools. Following steps explain how this approach works: - Expert users create design space exploration templates to capture digital product development workflows using the design and analysis tools of choice. These templates are saved, reviewed and released in the SDPM system. - Information about the design space exploration template – description, studies set-up, input files and parameters (inputs, outputs, constraints and variables) etc. are available in the SDPM system. Users can choose a desired design space exploration template based on information available in the SDPM system without having to launch the design space exploration tool. - Non-expert users (designers and analysts) can search in the SDPM system, find the desired design space exploration template and initiate a new design exploration by choosing the desired study, and adjust inputs (geometry, models, initial results etc.) from the SDPM system. - The SPDM system automates execution of the design space exploration analysis tools on local or remote machines. During the run, the currently explored design space results are available to review. A notification can be sent to the user when the process is complete. - Non-expert users can review results directly in the SDPM system to gain greater insight and understanding of the key characteristics that influence performance. Following are the benefits of this approach: - Knowledge capture of product validation workflows to reuse across the enterprise - Ability to hide workflow details and keep them confidential from the users - Non-expert users discover better designs, faster through design space exploration - Non-expert users can leverage high performance computing to reduce validation time - Non-expert users can gain greater insight and understanding about design performance - Complete traceability from requirements, to designs, to design space exploration templates and simulation results

Presenter Name: Kashid, Bipin

Presenter Company: Parker Hannifin Corporation- Hydraulic Valve Division

Presentation Title: Dynamic CFD Study of a Low Leakage Subsea Valve (B. Kashid, Parker Hannifin Corporation-Hydraulic Valve Division; Lvl: 1)

Type: Presentation

Keywords: Transient CFD, Dynamic Mesh, Cavitation, Design Optimization

Session Title: CFD: Optimization

Session #: 1-3

Room #: 26A

Abstract:

Directional control valves are widely used in many industries , including oil and gas. Increasing the performance efficiency of these valves by reducing cavitation is one of the key objectives for the designers attempting to increase reliability and reduce downtime due to failures. In this study, we have numerically studied the motion of a poppet in a 3D valve geometry to investigate the flow field, presence and location of cavitation spots as well as the flow forces acting on the poppet. Steady state/Static and quasi-static CFD simulations were performed to study and optimize the design. This was subsequently followed by transient dynamic CFD simulation. The motion of the poppet was included through the balance of a bias spring and hydrodynamic forces. A dynamic mesh strategy was utilized to accommodate for the motion of the poppet. The main outputs for the dynamic simulation were volumetric flow rates, flow forces acting on the poppet and cavitation hot spots. These outputs were further studied and investigated for various design iterations and the results compared favorably with the experimental data. Iterative CFD was done to validate the performance. By adjusting the CFD model to match the test data, each adjustment was done virtually and optimized before being done on the test stand. This continued correlation between simulation and experimentation gave a more holistic view of the valve performance and shortened the design cycle. This study played a crucial role in optimization of the valve geometry, which further resulted in reduced cavitation, enhanced performance, and increased life of the valve. Using a dynamic mesh strategy to model the fully transient dynamic behavior of the valve, early in the design cycle, provides engineers valuable insight about the behavior of the valve. This insight can further be used to optimize the design to resolve potential issues like cavitation, instability, reduced life, etc. before the prototyping stage.

Presenter Name: Khan, Amir

Presenter Company: rLoop Incorporated

Presentation Title: Supercharging Design Engineering with HPC Workflow Automation (A. Khan, rLoop Incorporated; Lvl: 2)

Type: Presentation

Keywords: automation, hpc, ROI, design exploration, rloop, rsystems, parallel computing

Session Title: Optimization 1

Session #: 1-1

Room #: 22

Abstract:

High-performance computing workflows, or the coupling of multiple software tools and computing resources into a desired dataflow, are plagued with ad-hoc approaches, limited availability of expertise, and complexity connecting to diverse computing resources. The benefits of automating such practices within an organization, however, are large but often difficult to identify a clear ROI to justify setup and resource costs. This presentation explores an open-source framework from Argonne National Laboratory used to facilitate the automation of an organization's HPC workflow processes. These workflows are then made available through Parallel Works, a SaaS offering for building, running and sharing parallel computing workflows, transparently connecting to R-Systems bare metal HPC infrastructure. We will demonstrate the application and ROI of workflow automation with the rLoop team, a complex decentralized organization designing and building one of the first Hyperloop pods. The Hyperloop is a proposed mode of passenger and/or freight transportation that combines the convenience of a train with the speed of an airplane via a levitating pod that may travel free of air resistance or friction conveying people or objects at high speed in a sealed tube or system of tubes. rLoop's Hyperloop pod design presents a range of interesting multiphysics challenges and simulation activities, including structural analysis, compressible and incompressible fluid dynamics, composite, electromechanical, and electronics design among others. This presentation will focus on demonstrating the value derived from rLoop's aerodynamic designs using incompressible solvers in OpenFOAM, a leading open-source fluid dynamics software that can be nicely parallelized both horizontally and vertically. Two ROI aspects will be demonstrated including the benefit of large-scale design exploration over the OpenFOAM automated pipeline, as well as the democratization of these encapsulated aerodynamics workflows throughout the decentralized rLoop organization. We will showcase and quantify benefits to the rLoop organization including a more productive use of their major computing software and hardware resources, rigorous interrogation of a model's parameter space leading to improved design, and the knowledge transfer of these computing practices from technical experts to engineers and analysts.

Presenter Name: Kia, Mohammad

Presenter Company: Caelynx LLC

Presentation Title: Effects of Insole-to-Midsole Heel Height on the Plantar Stress: A Finite Element Analysis (M. Kia, Caelynx LLC; Lvl:)

Type: Presentation

Keywords: insole, midsole, finite element, plantar stress

Session Title: Biomechanics

Session #: 2-1

Room #: 26B

Abstract:

The stress at the interface between foot and insole (i.e., plantar stress) is known to play an important role in development of foot ulcers in diabetic patients. A specific shoe design can potentially reduce the plantar stress and therefore provide more comfort for the patients. The objective of the study was to examine the effect of insole-to-midsole heel height on the plantar stress using a finite element (FE) model. A nonlinear axisymmetric two-dimensional model of a human heel-shoe consisting of calcaneus bone, heel pad, insole, midsole and a floor was developed in Abaqus/CAE. Non-linear foam material was assigned to the insole and midsole geometries. The total thickness of the insole-midsole was assumed a fixed number. The insole thickness was varied using Isight, while a representative average bodyweight was applied to the bone. A room temperature of 23°C was considered in this study. The plantar stress was estimated by measuring the predicted maximum contact pressure between the heel and the insole. The maximum contact pressure reduced by 10% from a thin to thick sole. Our model predictions showed that: 1) the contact pressure varies as a function of the insole-to-midsole heel height; therefore, an optimum ratio needs to be defined in designing a shoe and 2) under the room temperature condition, increasing the insole thickness can reduce the plantar stress (i.e., contact pressure between the heel and the insole). It is known that the foam material is temperature depended, therefore simulation of various thermal conditions needs to be considered next. The FE model was successfully used to perform a parametric optimization of the shoe dimensions with a view to predict the plantar stress. Development of a FE model allowed the automation of such design tasks which could otherwise be quite complicated due to the complexity of the physical problem and the range of usage conditions.

Presenter Name: Kim, Sangtae

Presenter Company: FunctionBay, Inc

Presentation Title: Mechanical System Simulation Opportunities Using Combined Multibody Dynamics and Particle-Based CFD (S. Kim, FunctionBay, Inc; Lvl: 1)

Type: Presentation

Keywords: Multi-physics, multibody dynamics, particle-based CFD, mechanical system

Session Title: Systems Simulation 2

Session #: 2-3

Room #: 26C

Abstract:

Multi-Body Dynamics (MBD) software has been used to investigate the dynamic behavior of the mechanical systems since the early 1980s. Since that time MBD software has continually added capabilities to simulate related physics and/or numerical methods, such as control system modeling, linear and nonlinear flexible bodies, Design of Experiments (DOE), and system-level optimization. Starting a bit more recently, Computational Fluid Dynamics (CFD) has been used to understand the characteristics of fluid flow, including the distribution of fluid pressure. While the operation of many products includes the combination of moving mechanical assemblies and fluids, co-simulations could not be done because the two different simulation domains could not be properly coupled because of technical reasons. For example, traditional CFD uses a mesh-based computational approach, while the changing configurations of the MBD mechanical system causes continual changes of the available volume for the fluid. Another consideration was the proper exchange of forces and momentum between the fluid and the moving components. This presentation explains how a particle-based CFD method, the so-called MPS (Moving Particle Semi-implicit) method can be used with MBD software. The MPS method is a formulation for modeling fluid dynamics for uncompressible fluids, using a Lagrangian approach. In contrast with conventional CFD methods that require meshes, the MPS method models fluids using particles. This approach allows for easy modeling of the free surfaces of fluids and for modeling multiple fluid types together, along with the boundaries between these fluids. As a result, the MPS method provides a remarkable advantage in simulation of free surface flows and complex boundary geometries. Since this method doesn’t use a mesh, co-simulation with MBD works well. In this presentation, a new and strong coupling method between MBD and CFD will be introduced, together with several industry case studies. The highest interest in the automotive industry has been observed in two areas. The first is the interaction between the lubricating fluid and the moving mechanical components in transmissions and axles. The second is the simulation of fluid flow in the undercarriage and the engine compartment of a vehicle. Given the higher voltages that are present in hybrid and electrical vehicles, it is important to understand the distribution of water as the vehicle operates in roads with puddles.

Presenter Name: Kleidarias, Stavros

Presenter Company: BETA CAE Systems SA

Presentation Title: A Unified Environment for Collaborative CAE and Immersive Simulation Results' Processing (S. Kleidarias, BETA CAE Systems SA; Lvl: 2)

Type: Presentation

Keywords: Virtual Reality, Collaboration, Photorealistic, Rendering, Web Interface

Session Title: Virtual/Augmented Reality

Session #: 3-2

Room #: 25A

Abstract:

Ever since the first CAE simulations there has always been a need to examine digital models as close to reality as possible. Technology limitations meant that this was done on digital models with unrealistic graphics representation and on a PC monitor. Also, the evaluation of simulation results by engineering teams on different design centers was proven to be inefficient and time consuming, being based on exchanging tediously prepared images, videos and reports. BETA CAE Systems has invested heavily in this field to offer a complete solution in the form of a collaboration hub. Through this hub engineers, even from different physical locations, can meet in virtual working rooms and collaborate using the software solutions of BETA CAE Systems easily and efficiently. These solutions span from process orchestrating, data management, modeling, solving, and results visualization. Collaboration can be in the 2D field, using common PC monitors, handheld devices, or even in a virtual reality using META, the post-processor of BETA CAE Systems, through its support of the HTC VIVE and Oculus VR headsets. It also offers the capability for communicated with text or audio/video and file posting and sharing with encryption. Sessions can also be recorded for later playback along with notes (sketches, annotations, etc.). This solution offers to engineers a unique tool for the evaluation of LS-DYNA simulation results with unrivalled realism, aided by the Physically Based Rendering (PBR) and environment mapping capabilities of META. Engineers can easily assign Physically Bases Rendering materials on simulation models and load image backgrounds, the reflections of which will be realistically rendered on the model, closely matching the displaying quality of render dedicated software. All above applications can run on cloud. With this cutting edge technology BETA CAE Systems offers to engineers a powerful tool that paves the way for the collaborative CAE analysis of the future.

Presenter Name: Knudsen, Linda

Presenter Company: Syncroness

Presentation Title: Assessing Credibility of Computational Models through Verification and Validation: Application to Medical Devices (L. Knudsen, Syncroness; Lvl: 2)

Type: Presentation

Keywords: Life Sciences - Medical Devices, Uncertainty Quantification, Validation & Verification

Session Title: Simulation Governance: Verification & Validation 1

Session #: 3-2

Room #: 24

Abstract:

ASME's V&V Standards Committees are responsible for creating V&V best practices, general guidance, a common language, and application-specific guidance documents. Although methods for V&V are well-established, guidance has been lacking on assessing the adequacy of the V&V activities for computational models used to support medical device development and evaluation. The V&V 40 subcommittee is focused on application to medical devices, and the forthcoming V&V 40 standard - Assessing Credibility of Computational Modeling and Simulation Results through Verification and Validation: Application to Medical Devices – is intended to address the need for guidance in this area. Computational modeling can be used to provide information that supports decisions related to the technical performance, safety and/or effectiveness of medical devices. Computational models can be used throughout the total product life cycle of medical devices, from initial concept, design and development, to support of nonclinical and clinical activities, to post-market surveillance. Medical device manufacturers may utilize computational models to augment in vitro and in vivo evaluations, or where such evaluations are unjustifiably invasive, prohibitive, and/or deemed unreasonable. Moreover, computational models can also be used to evaluate options not possible experimentally or clinically. Computational models can also be used to assess aspects of in vivo performance without subjecting patients to potential harm or unnecessary risk. The potential consequence of an incorrect assessment elevates the importance of being able to establish the credibility or trust in the predictive capability of a computational model. Given the inherent risk of using a computational model as a basis for predicting medical device performance, a risk-informed credibility assessment framework has been developed. The framework centers on establishing that model credibility is commensurate with the risk associated with a decision based in part on the computational model. Thus, the intent of this standard is to provide guidance on how to establish the credibility requirements of computational models based on risk, and then determine and communicate the credibility of computational models used in the evaluation of medical devices through V&V activities. This presentation will provide a high-level overview of the risk-informed credibility assessment framework, focusing on the new concepts that V&V 40 is introducing into the ASME V&V family of documents.

Presenter Name: Kokaly, Matt

Presenter Company: MSC Software

Presentation Title: Open MBE: Removing Limitations (M. Kokaly, MSC Software; Lvl:)

Type: Presentation

Keywords: MBE, Open standards, data mangement, model defiinition, model authoring, model results

Session Title: Simulation Governance: Collaboration 1

Session #: 1-1

Room #: 24

Abstract:

Some of the benefits of an MBE approach to simulation are the ability to reuse models, coordinate the current design configuration across multiple simulations and concentrate IP in a more centralized way. Proprietary datasets and systems make this extremely difficult or impossible to do outside of the closed environment they were created for. This forces end users to make a hard decision between choosing the right tool for the right job or choosing an environment that potentially improves the process flow. Best in class and purpose fit vs the potential of integration. There are several roadblocks to realizing these benefits via an "Open MBE process". We will review current practical solutions to four of these challenges: 1. Open format and standard for model definitions: One challenge has been mostly solved by the passage of time, industry consolidation on a basic feature set to make defining a standard schema practical. The other challenge has been to define a format that does not restrict vendors while allowing for reuse of the majority of the model definition. A solution based on HDF5 will be proposed. 2. Open model authoring environments: While GUIs for creating models must remain proprietary in order to achieve ever increasing levels of performance, the scripting and customization of them do not. The rise of the Python as a common and powerful programming language shows how rich APIs can be combined with community developed libraries by end users to extend functionality beyond what is possible by a single vendor. 3. Open format and standard for model results: As with model definition, the majority of the challenge of developing a standard output schema has already been overcome as simulation has matured. What remains is choosing a format. We will discuss how HDF5 is an open, flexible format that satisfies vendors needs and the value it provides beyond an open data format. 4. Open simulation data management: PLM systems are the backbone of many large enterprises and simulation should be better integrated. The difficulty with simulation is that the number of tools (vendor and user created) is much larger than with PDM as is the engineering process itself. As a result, a solution specific to simulation is needed. This solution must be open to not only the broad range of engineering tools available today but also to integration in the greater enterprise PLM system. The adoption of open standards is vital and we will discuss recent experience with working with tools and enterprise systems. The framework and tools for an OpenMBE system exist today. With more investment and involvement of the community, the promise of an open and effective MBE approach can be achieved.

Presenter Name: Konno, Juho

Presenter Company: Wartsila Finland Oy

Presentation Title: Requirement and Task Management as a Part of Wartsila Digital Design Platform (J. Konno, Wartsila Finland Oy; Lvl: 2)

Type: Presentation

Keywords: requirement management, task management, SLM, data management

Session Title: Simulation Governance: Data Management 3

Session #: 2-3

Room #: 24

Abstract:

We present a methodology for systematically using an SPDM platform as the cornerstone of product development. The target is to base product development on clearly defined targets and requirements in different phases of the product development lifecycle. This is achieved by means of a data-centered approach where all data is retained in a digital form in the platform. Instead of reporting, users are provided with different views to the same data. We will demonstrate how a static document-based validation system can be replaced by a common validation data platform. In addition, we aim to base the validation requirements on a reliability analysis workflow. In this case, the platform is used not only to handle the simulation data but to encompass the whole product validation scope. To this end, we show how to couple requirements to the simulations and handle all the design decision data together with the simulations and use these to drive the design, in the form of task management. In addition, we present ways to replace simulation reports with dynamic dashboards. To complete the loop, we touch the topic of PLM integration as a tool for assuring completeness of validation data in the product lifecycle. The motivation for the activity is a dramatic reduction in product development time based on a possibly somewhat longer concept phase but less iterations during the detail design phase. We will also present decision making based on data stored in the platform as well as demonstrate the data-centered approach to validation data. In addition, other benefits such as the re-use of data and simulation workflows along with the automatically handled data management are demonstrated. To conclude, some end user opinions and experiences in adopting a new system will be presented. Future developments will include moving also the physical testing data and coupling that with the corresponding simulations and validation requirements.

Presenter Name: Koppenhoefer, Kyle

Presenter Company: AltaSim Technologies LLC

Presentation Title: Simulation of a Vibrational Scalpel (K. Koppenhoefer, AltaSim Technologies LLC; Lvl:)

Type: Presentation

Keywords: Harmonic scalpel, thermoelastic damping, piezoelectric, heat transfer

Session Title: Multiphysics 3

Session #: 3-2

Room #: 21

Abstract:

Medical scalpels that use high frequency, harmonic vibrations to cut tissue have been developed by several companies. These surgical devices simultaneously cut and cauterize by heating tissue as a result of applying vibrational energy. Typically, the vibrational energy of these devices is driven by piezoelectric transducers that convert an electrical signal into mechanical vibrations at frequencies in the range of 50 to 60 kHz. The piezoelectric vibrations travel along a waveguide that can be of a length from 10 to 40 cm. The waveguide then directs the vibrational energy into the tissue. The high frequency, low amplitude vibrations generate heating of the device as well as the tissue. Computational simulation can be used to help design this class of scalpels. Prototype designs of these scalpels have become hot enough to burn the surgeons hand, thus, developing an understanding of the temperature distribution of the device is critical to a successful design. However, due to the strong coupling between the piezoelectric transducer, the structural vibration and the heating due to thermoelastic damping. a challenging Multiphysics problem is created. A fully coupled piezoelectric, structural vibration, and heat transfer analysis of the scalpel has been conducted using COMSOL Multiphysics®, and the simulation results used to predict the temperature distribution in the device. Analysis of vibrational scalpels includes the electrical excitation of a piezoelectric stack that produces a mechanical vibration of the stack. This vibration excites a rod near a resonant frequency to maximize deflection of the surgical tip of the rod. The vibrational deformation of the rod produces a change in internal energy. During the compressive phase of the vibration, the material is heated, and the tensile phase cools the material. The temperature gradients that develop produce heat transfer in the device thus dissipating energy. This thermoelastic damping produces a heat source in the model that couples the mechanical vibration and heat transfer.

Presenter Name: Kornfein, Mark

Presenter Company: GE Global Research & Development

Presentation Title: Wind ITO Fulfillment Center: Capturing Proprietary Processes for Wind Farm Siting Analysis (M. Kornfein, GE Global Research & Development; Lvl: 1)

Type: Presentation

Keywords: Collaboration Tools and Techniques, Capturing Proprietary Processes within Apps

Session Title: Democratization 4

Session #: 2-2

Room #: 23

Abstract:

Mark Kornfein, Ching-Ling Huang KORNFEIN@GE.COM, CHINGLING.HUANG@GE.COM GE Digital Research, General Electric Global Research Center When manual engineering processes are automated, it is crucial to make sure that these proprietary processes are properly captured. The siting analysis of a wind farm involves multiple steps to determine the feasibility of installing one or multiple models of wind turbines in specific locations. Among many environmental and legal considerations, it is essential to determine the engineering feasibility of installing wind turbines, which is based on ambient wind conditions, turbulence and geographical data in the selected location and the characteristics of the selected turbine models. Previously these evaluation processes for site-specific mechanical loads analysis (MLA) were done by geographically distributed experts on their local desktop computers with isolated software applications with multiple manually produced input files. A system called Wind ITO Fulfillment Center (WIFC) was created to provide a streamlined approach to wind farm siting, enabling a unified method to execute a disparate set of specialized analyses and programs from a common web interface. WIFC serves as a centralized online portal for siting information, storage, review and analysis of applications for wind turbine MLA and general siting suitability. Site specific information on ambient wind conditions, environmental and geographical data along with the specifications of selected turbine models are the inputs to this system. All the engineering programs and related libraries used in the analyses are stored in a centralized file system. As algorithms and programs are enhanced or replaced, they can be updated to the live system without disrupting existing processes. WIFC framework was designed with several goals in mind: 1) Support a diverse set of new or legacy siting analysis applications on multiple OS platforms (Windows, Linux, Unix, etc.); 2) Modular to allow quick adaptation or plug-in of engineering or business tools that interact with data already in the system; 3) Offer the ability of quickly prototyping to add new functionalities; 4) Allow rapid deployment of new code and applications to the system. WIFC was developed using proprietary algorithms, custom software, and commercial off-the-shelf tools. For its web frontend and some backend processes, Enterprise Accessible Software Applications (EASA) system was used. EASA allowed for rapid web user interface development, automated job queuing, and seamless connectivity to computational servers. Custom algorithms were developed to generate inputs, post-process outputs of engineering programs, and execute workflow between processes. This system has resulted in a siting process that provides unified, consistent and reproducible results, a common knowledge base that allows data validation and verification of past analyses, enhanced productivity and a quicker turn-around time on analyses. Recently added functionalities to this system include component level analysis, Automated Configuration Release, and Turbine Allocation. Component level analysis enables users to run suitability analysis on critical components of a wind turbine model, like towers or foundations. Automated Configuration Release is a process to enable users to test the validity of tools for new wind turbine models prior to their formal release and usage in wind farm siting. Turbine Allocation allows engineers to rapidly vary turbine models on a turbine by turbine basis to calculate the predicted energy for a proposed wind farm site. Turbine Allocation runs on the Predix platform by GE Digital to utilize unified web widget design and backend microservices. Our future work aims at enriching this system with better parallel computation to reduce latency, more scalable architecture and load-balancing, and the possibility of employing machine learning techniques for automated optimization and selection of wind turbine models.

Presenter Name: Liao, Ben-Shan

Presenter Company: Siemens PLM Software

Presentation Title: A Model Order Reduction Scheme for Frequency Dependent Vibro-Acoustic Applications (B. Liao, Siemens PLM Software; Lvl: 2)

Type: Presentation

Keywords: vibro-acoustic, model order reduction, Krylov subspace, frequency response analysis

Session Title: Vibro-Acoustics

Session #: 2-1

Room #: 26A

Abstract:

Frequency response analysis in vibro-acoustic applications involves solving the system of equations obtained from a finite element discretization for each excitation frequency over broad frequency ranges. The direct (full FE model order) approach becomes impractical for large models and many frequency points due to high computational cost in terms of elapsed time and computing resources. Many model order reduction techniques have been developed to reduce the computational complexity. These approaches include modal based reduction methods and Krylov subspace based reduction methods. The modal based approach has been commonly used in commercial software and works well for many structural applications. However, this approach is limited in the vibro-acoustic applications. First, it becomes less efficient when the damping presents. Moreover, the modal approach based on frequency independent stiffness and mass matrices make it inappropriate for frequency dependent applications. An alterative is Krylov subspace based approach. These algorithms such as Pade-via-Lanczos (PVL) and second order Arnoldi (SOAR) have been successfully applied to interior acoustic applications with constant impedance in which the system matrices are frequency independent. That is, the stiffness, mass, and damping matrices of the system are constant. However, in many real-life engineering acoustic applications the system matrices are frequency dependent. For example, modeling the exterior acoustic problems uses the introduction of locally conformal Perfectly Matched Layers. In such case, Krylov subspace based algorithms are not directly applicable. To overcome this shortcoming, one approach has been proposed in which PVL is implemented in combination with a Dirichelt-to-Neumann (DtN) map. That requires reformulating the finite element problem. Here we propose an approach by combing a Krylov subspace solver with a substructuring procedure. Three case studies are presented to show the accuracy and efficiency of the method.

Presenter Name: Lin, Guoyu

Presenter Company: ANSYS Inc.

Presentation Title: A Gradient-Regularized Coupled Damage-Plasticity Microplane Model for Concrete-Like Materials (G. Lin, ANSYS Inc.; Lvl: 3)

Type: Presentation

Keywords: Concrete, damage, nonlocal approach, microplane, three surface Drucker-Prager model

Session Title: Structural Analysis 2

Session #: 1-2

Room #: 26B

Abstract:

Concrete, granular materials such as sand and soil, and powder compaction are often modeled using strain softening materials, which are known to be plagued by numerical instability and pathological mesh sensitivity in a finite element analysis. To overcome this a coupled damage-plasticity microplane model, which uses an implicit gradient regularization scheme, is introduced. Implicit gradient regularization, a class of nonlocal methods, enhances the local equivalent strains by considering its nonlocal counterpart as an extra degree of freedom governed by a Helmholtz-type equation. This results in a smooth deformation field avoiding displacement discontinuities, which can lead to an ill-posed boundary value problem. A tension-compression split, to account for the transition of the stress state in cyclic loading and the difference in tension and compression damage, adds two extra degrees of freedom per node. Microplane plasticity is introduced, using microplane quantities, through laws resembling classical invariant-based plasticity models, enabling material models with a direct link to the conventional macroscopic plasticity models. The plasticity in this model is defined via a three-surface microplane Drucker-Prager model, covering a full range of possible stress states experienced in cyclic loading. The smoothness of the yield surface allows for a stable return mapping algorithm. The damage evolution behavior is motivated by the material behavior of concrete and similar materials. To realistically model the damage of concrete subject to cyclic loading, the initiation of damage and its subsequent evolution can be different between compression and tension. Furthermore, in the transition from tension to compression states, the stiffness lost during tensile cracking is recovered due to crack closure. The extra degrees of freedom essentially imply a coupled field problem and the system of equations are solved simultaneously. Examples of plain and reinforced concrete are conducted and comparisons against experiments conducted by other authors are shown to evaluate the model.

Presenter Name: Lin, Guoyu

Presenter Company: ANSYS Inc.

Presentation Title: SMART Method for Automatic Simulation of Static and Fatigue Crack Growth (G. Lin, ANSYS Inc.; Lvl: 3)

Type: Presentation

Keywords: crack growth, fatigue, fracture

Session Title: Fatigue & Fracture

Session #: 1-3

Room #: 26B

Abstract:

Fracture and durability analysis plays a significant role in the design of modern structures against fatigue and failure. Modern structural design utilizes more and more advanced material and greatly elevates the design requirement. Often existence of initial defects and cracks in structure components is inevitable even before the service, therefore it is of great interest in the engineering design to make accurate prediction of the fatigue crack initiation and growth life for structures and to be able to predict the catastrophic failure of the structures. Crack growth is the separation process of crack surfaces and implies that the crack geometry changes. The most direct method for crack-growth simulation uses a remeshing technique to accommodate the changes in the fracture process. ANSYS SMART (Separating, Morphing, Adaptive and Remeshing Technology) Crack Growth method offers remeshing-based tools for automated crack-growth simulation in engineering structural components. A key component of the technology is the crack representation during crack growth. SMART Crack Growth method uses a combination of automated morphing, adaptative and remeshing techniques to accommodate the mesh changes due to crack growth. The mesh updates occur around the crack-front region only and is integrated into ANSYS APDL solver solution kernel. The scheme ensures the analysis completely inside solver without the need of leaving the solver solution and any manual intervention, therefore leading to a very computationally efficient solution scheme for the crack-growth problem. The crack growth mechanics include both fracture criteria of J integral and stress intensity factors for static crack growth modeling and Paris' Law for fatigue crack growth simulation. The relevant fracture mechanics parameters and other solution variables such as crack extension, fatigue cycle number are all calculated during the solution and saved to ANSYS ADPL results file for post processing. Several examples are given to show how ANSYS SMART Crack Growth method can be used to model both static and fatigue crack growth.

Presenter Name: Lin, Guoyu

Presenter Company: ANSYS Inc.

Presentation Title: Introduction to Material Force for Fracture Application (G. Lin, ANSYS Inc.; Lvl: 3)

Type: Presentation

Keywords: fracture, material force, crack

Session Title: Fatigue & Fracture

Session #: 1-3

Room #: 26B

Abstract:

Efficient and realistic analysis by using fracture mechanics based design of products relies on several important aspects: • Material behavior (linear or nonlinear, time-dependent, temperature a moisture effects, hysteresis due to plasticity or visco-elasticity, anisotropy, description of micro structure of constituent, etc.) • Determination of material parameters from test data • Definition of the term durability of a product (fracture-based fatigue or failure, stress–strain-based fatigue or failure, mechanics-based statistics of failure risk, etc.) • Use of correct failure model and fracture parameter Contrary to physical force, which can be traced back to Newton and Galilei, material force act on the material manifold. Thus, they essentially represent discontinuities and inhomogeneities such as imperfections, inclusions, voids, cavities, wave fronts, cracks and material inhomogeneities etc. This paper introduces a new material force concept to fracture addressing the issues arise due to cracks/defects. Based on mechanics in the material space, a concept of mate¬rial force can be interpreted as force vectors acting on imperfections and dislocations, and therefore crack/fracture driving force in the context of linear and nonlinear fracture mechanics. For linear elastic fracture mechanics (LEFM), the material force is equivalent to energy release rate and for elastic-plastic fracture mechanics (EPFM) with monotonic loading condition, the material force is equivalent to J-Integral. However, material force is applicable for a much broad physics behavior including but not limited to rate effect, cyclic effect and anisotropic etc. This makes material force as a parameter uniquely suitable for simulating complex physics of fracture phenomena. The material force approach is an advanced feature that is a more general and easy-to-use method to asses fracture mechanical criteria and the crack propagation direction. Material force evaluation implemented in ANSYS APDL solver is based on continuum mechanics and material force vectors that act on cracks. Several examples are given to show how material force is evaluated for elastic, plastic and hyperelastic materials and material force is equivalent to J-Integral for linear material and elastic-plastic materials.

Presenter Name: Loghin, Adrian

Presenter Company: Simmetrix Inc.

Presentation Title: Life Prediction Modeling Capabilities for FE Applications (A. Loghin, Simmetrix Inc.; Lvl: 2)

Type: Presentation

Keywords: life prediction, crack propagation simulation, damage modeling, finite element analysis

Session Title: Fatigue & Fracture

Session #: 1-3

Room #: 26B

Abstract:

Crack propagation life assessment of engineering structures is an integral part of well-established Damage Tolerant Design (DTD) practices in aeronautical industry. In the recent years other industries adopted DTD procedures to design components that pose safety concerns. New developments (Structural Health Monitoring, Probabilistic Rotor Design) that make use of fatigue and fracture knowledge emerged in an effort to better quantify inspection intervals, set maintenance procedures or assess the risk of failure. The Digital Twin concept laid out by AFRL and NASA, re-emphasizes development of three-dimensional deterministic damage accumulation models reinforced by probabilistic methods to assess structural integrity of an aircraft structure. The need for robust and ease-of-use damage modeling capabilities at component level is desirable for a more accurate predictive life assessment capability in the industry. Various finite element modeling capabilities have been developed at Simmetrix to satisfy the industry level requirements for crack propagation simulation and life assessment. The procedures employ existing CAD models or component level finite element meshes to efficiently reuse data developed in the design process. The crack insertion process can use a planar or non-planar surface definition to represent the initial crack surface and further simulate crack propagation in any geometry without constraining crack surface to a predefined shape. Same procedure is followed to define, insert and mesh models containing multiple cracks without additional effort from the user to pursue a more complex life assessment. For composite structures, the developed capabilities allow single or multiple crack insertion along a three-dimensional material interface or across the interface to support delamination studies or translaminar damage life assessments. Another area where these lifing related modeling capabilities could be applied, are related to segmentation and reconstruction of volumetric measurements. Different examples are presented to provide details on implementation and portability of the remeshing procedures to demonstrate usability of damage modeling capabilities.

Presenter Name: Luscher, Tony

Presenter Company: The Ohio State University

Presentation Title: High Speed Multi-Ridged Nailing Process Simulation Using SPG Method (T. Luscher, The Ohio State University; Lvl:)

Type: Presentation

Keywords: manufacturing modeling, Smooth Particle Galerkin, automotive

Session Title: Simulation of Manufacturing Methodologies & Processes 2

Session #: 3-2

Room #: 25B

Abstract:

Automotive joining and fastening is in a period of rapid transition due to the use of multiple materials in innovative vehicle structures. One promising concept is the use of high-speed ridged nails to join steel, aluminum, and composites, both alone and in conjunction with adhesives to form hybrid joints. This paper describes the creation and verification of an LS-DYNA Lagrangian and Smoothed Particle Galerkin (SPG) model of this joining process. The multi-ridged nail, made of high strength steel, has a shaft diameter of 3 mm and is modeled as a rigid body. During assembly, the nail is driven into two Aluminum 6061-T6 sheets modeled as discs with a total 3.175 mm thickness with a velocity of 33.9 m/sec. One of the challenges of this model, and the reason for applying the SPG approach, is the large scale localized deformation, and the filling of the steel ridges with the material from the surrounding aluminum plates. Accurate modeling of this is essential to predicting the load carry capability of the joint. Conventional Lagrangian methods were tried but were unable to accurate model this phenomena. Another concern is the formation of petals as the nail exits the bottom plate as these also greatly contribute to retention. The formation of these petal is complex with fracture lines being part of the deformation, but also a circumferential tearing similar contributing to the deformation field. Material considerations greatly affect the results and the aluminum plates have been modeled as deformable bodies with a Johnson-Cook strain-rate dependent plasticity model. The model was calibrated by comparing the deformation field of both the simulation and experimental results. Strength of the joint was determined by the force needed to push the nail out from the bottom. This validated model can be used to develop more optimal designs for automobile joining.

Presenter Name: Luz, André

Presenter Company: Infinite Foundry

Presentation Title: Simulation as a Service in the Cloud (A. Luz, Infinite Foundry; Lvl: 1)

Type: Presentation

Keywords: Cloud, HPC, SaaS, CAE Integration

Session Title: Cloud

Session #: 3-3

Room #: 25C

Abstract:

Digital twin allows linking real-time data with 3D digital mock-ups in order to predict product behavior and optimize service performance in real time. In addition, by analyzing the IoT data that comes in, an engineer can compare real operation performance with predicted one, so that it can detect and fix problems in the design as early as possible, minimizing costly recalls. This feedback mechanism of service performance back to the engineering center allowed by a digital twin is particularly useful in industries that produce products with long service lifetimes. The problem is a digital mock-up is not stored in a single data center, but in multiple data centers that belong to different suppliers. Therefore, a cloud platform is needed to link data stored in different centers and stream it to the cloud in order to process it using simulation and artificial intelligence software. Infinite Foundry cloud platform does exactly this. It is currently being used by Volkswagen and Daimler to build and manage digital twins from the plant and vehicles. These digital twins are helping these customers to optimize production and vehicle design, as well as offer advanced fleet management software solutions that include smart predictive maintenance according with individual vehicle usage. In this presentation, some industrial case studies will be discussed in order to understand return of investment for the automotive industry when using digital twin technology from a cloud platform. In particular, it will be shown a case study of a plant to change and optimize assembly layout, a case study of a vehicle during the design stage in order to predict product performance and eliminate costly physical testing, and a case study of predictive maintenance for fleet management that uses IoT data to calculate remaining lifetime of critical components. Cybersecurity issues will also be discussed, in particular how using a hybrid approach (on-premises and cloud) with a high level encryption provides a secure environment to store and analyse confidential data.

Presenter Name: Mach, Rod

Presenter Company: TotalCAE

Presentation Title: Roadmap to Adopting Private or Public Cloud Simulation as a Service (R. Mach, TotalCAE; Lvl: 2)

Type: Presentation

Keywords: Cloud vs. Cluster vs. Data Center vs. SaaS

Session Title: Cloud

Session #: 3-3

Room #: 25C

Abstract:

Learn how companies are adopting the latest trends High Performance Private and Public Cloud Computing to accelerate simulation and data management. Several customer case studies will be presented to show real-world solutions to customer challenges, and a roadmap to adopting simulation as a service. Topics include: 1. Types of Cloud Computing for Engineers - Private (Hosted or Customer Datacenter) - Public - Hybrid - ISV Application Native 2. Pros of Cons of Each option and how to select the right strategy for your company. 3. How to choose between various major public cloud options - Azure - AWS - GCE 4. FEA/CFD licensing in the cloud 5. Data Bottleneck Solution Overview - remote viz - compression technologies - scripting techniques 6. Security 7. Real world ROI 8. Benchmarks - On Premise HPC cluster vs Cloud - Cloud vs Cloud 9. Real World Customer Case Studies - Medical Devices - Secure Cloud Data Storage for Simulation Data - Automotive - Hybrid Cloud for CFD - Consumer Electronics - Private Cloud Simulation as a Service - Automotive - Hosted Simulation as a Service - Oil and Gas - Public Cloud Unlimited Design of Experiments - EDA - Customer ROI Case Study At the end of this presentation attendees will have a good understanding of the current landscape for HPC computing for private and public cloud, and how leading companies are adopting these technologies to speed up their time to market. Speaker Bio: Rodney Mach is President of TotalCAE, a leading provider of Managed FEA/CFD Private & Public Cloud HPC solutions. Rod is a 21 year veteran in utilizing High Performance Computing for engineering simulation. Mr. Mach has a B.S.E in Electrical Engineering from the University of Michigan, and MBA from Wayne State. Prior to starting TotalCAE in 2006, he led the University of Michigan High Performance Computing center.

Presenter Name: Makwana, Rahul

Presenter Company: Detroit Engineered Products

Presentation Title: Rapid CAD Generation and Optimization for Vehicle Design and CAE Engineers (R. Makwana, Detroit Engineered Products; Lvl: 2)

Type: Presentation

Keywords: CAE (Computer Aided Engineering), CAD (Computer Aided Design), FEA (Finite Element Analysis), CAD Morpher

Session Title: CAD / CAE

Session #: 3-3

Room #: 26B

Abstract:

In the automotive industry, a good hand-shake between Computer Aided Design (CAD) and Computer Aided Engineering (CAE) engineers is imperative in order to deliver a great and reliable product meeting all their respective disciplines and guidelines such as styling, ergonomics, packaging, safety, noise and vibration, robustness to name a few. Such process involves rapid back and forth changes flowing between the design CAD and its final verification with the help of computer simulations with the aid of finite element analysis (FEA). Any recommend design changes by CAE division after evaluation, goes back to the CAD department and the changes in the CAD are made. This cycle seems to follow a generic and somewhat time consuming process of design/product development. The present case-study presents one such approach as CAD-driven morphing; utilizing morphing techniques on CAD model (s) to bring about design changes independent of CAE. MeshWorks CAD Morpher developed by Detroit Engineered Products (DEP) has been used to create morphed CAD models at full vehicle and sub system levels for design creation at different (initial concept, tuning and final) vehicle development stages in various measures. The utility of the tool is presented with some of the typical challenges faced by CAE and CAD engineers and how the tool is used in order to solve those complex situations with the help of some test cases such as morphing of the CAD surfaces in the initial phase without interaction with CAE. In addition, generation of CAD from final optimized CAE model capturing all the complex features such as fillets, rounds etc. The ability of CAD morphing tools to make design changes in CAD model adds comprehensive value to the overall development process, thus enhancing and reducing the overall product development time. Keywords: CAE (Computer Aided Engineering), CAD (Computer Aided Design), FEA (Finite Element Analysis), CAD Morpher

Presenter Name: Mandava, Prasad

Presenter Company: Visual Collaboration Technologies Inc

Presentation Title: Smart “3D CAE Report” for Making Faster Design Decisions throughout the Product Life Cycle (P. Mandava, Visual Collaboration Technologies Inc; Lvl: 1)

Type: Presentation

Keywords: CAE Report, 3D, CAE Results, Simulation, Post Processing, SPDM, PLM, SImulation Data, SImulation Information, Smart, Meta Data

Session Title: Simulation Governance: Collaboration 2

Session #: 1-2

Room #: 24

Abstract:

Efficient use of Simulation Results in making design decisions is becoming a key enabler of strategic goals for improving competitiveness and profitability. Many different Simulation tools, many data formats, huge data files, complex post processing requirements and limited 3D collaboration options are the main bottlenecks in effective communication of simulation information to make design decisions. Intelligent Simulation Information extracted from bulky result files is critical to be available to all stakeholders at the right time, for critical decision making, throughout the product development process. Most of the simulation tools support interactive approach to view 3D simulation results. It is common practice for analysts to open the CAE results files, find the peaks or failure points, annotate them in power point and create as many slides in power point. Common practice of creating such 2D image (and Video) based reports is cumbersome, error prone and is not sufficient to validate models and results for complex 3D assemblies. Many iterations are required to communicate simulation information to the designers. There can be miss-communications which could lead to sub optimal designs or design errors. In global design scenario, simulation task may be split into different groups and effective 3D Simulation information sharing is critical for effective validation of CAE models, communicating with designers and using simulation in design optimization cycles. In this paper, the authors discuss smart ways of extraction and transformation of native simulation data into Intelligent 3D Simulation Information. Different ways of creating and sharing of 3D reports for effective communication & collaboration of Simulation information are discussed. Extraction of Intelligent Simulation Information from large simulation data file of different format is time consuming and error prone. An intelligent way to post process simulation data using scripts and temples are also discussed in this paper. Most of the SPDM systems are web based applications and support html reports. Web based 3D CAE Reporting options are discussed in detail with examples.

Presenter Name: Maor, Ophir

Presenter Company: HPC Advisory Council

Presentation Title: The Effect of In-networking Computing Capable Interconnects on the Scalability of CAE Simulations (O. Maor, HPC Advisory Council; Lvl: 2)

Type: Presentation

Keywords: HPC, In-Network Computing, Scalability

Session Title: High-Performance Computing/Supporting Infrastructure

Session #: 2-3

Room #: 25C

Abstract:

From concept to engineering, and from design to test and manufacturing, engineers from wide ranges of industries face ever increasing needs for complex, realistic models to analyse the most challenging industrial problems; Finite Element Analysis is performed in an effort to secure quality and speed up the development process. Powerful virtual development software is developed to tackle these needs for the finite element-based Computational Fluid Dynamics (CFD) simulations with superior robustness, speed, and accuracy. Those simulations are designed to carry out on large-scale computational High-Performance Computing (HPC) systems effectively. The latest revolution in HPC platforms is the move to a co-design architecture to reach Exascale performance by taking a holistic system-level approach to fundamental performance improvements. Co-design architecture exploits system efficiency and optimizes performance by creating synergies between the hardware and the software, and between the different hardware elements within the data center. Co-design recognizes that the CPU has reached the limits of its scalability, and offers an intelligent network as the new “co-processor” to share the responsibility for handling and accelerating application workloads. By placing data-related algorithms on an intelligent network, we can dramatically improve data center and applications performance. Smart interconnect solutions are based on an offloading architecture, which can offload all network functions from the CPU to the network, freeing CPU cycles and increasing the system’s efficiency. With the new efforts in the co-design approach, the new generations of interconnects include more and more data algorithms that can be managed and executed within the network, allowing users to run data algorithms on the data as the data being transferred within the system interconnect, rather than waiting for the data to reach the CPU. These interconnects deliver In-Network Computing and In-Network Memory, which is the leading approach to achieve performance and scalability for Exascale systems.’ HPC Advisory Council performed deep investigations on a few popular CFD software to evaluate its performance and scaling capabilities and to explore potential optimizations. The study reviews the recent developments of in-network computing architectures, and how they can influence on the runtime, scalability and performance of CAE simulations.

Presenter Name: Marchand, Yanis

Presenter Company: Romax Technology Inc

Presentation Title: Assessment of Gearbox Durability Using a Customized App (Y. Marchand, Romax Technology Inc; Lvl: 1)

Type: Presentation

Keywords: Custom app, appification, democratization, gearbox durability

Session Title: Democratization 5

Session #: 3-1

Room #: 23

Abstract:

This abstract explores an application that is being developed by Romax Technology Limited with the aim to automate the analysis of wind turbine gearboxes. The application endeavors to enable a person who is not an expert with CAE tools to run static analyses on several gearboxes and duty cycles, and then select the one that best matches their requirements based on various criteria. While it may be the case that several gearboxes are available, the customer is only interested in the most applicable to their needs, even if other designs developed might be useful in other scenarios. However, the customer cannot know which one will match their requirements without any analysis. Furthermore, the commercial team selling the gearbox may not be aware of the duty cycle that the customer has defined for the gearbox. Thus, the application enables the two roles to communicate in a highly efficient manner in order to fulfill the customers' requirements. Specifically, the app uses the concept of batch submission and three different software technologies: RomaxWIND, EASA and Excel. RomaxWIND enables the user to carry out powerful calculations and analyses, but because the goal is to enable anyone to use this CAE tool, we employ EASA to build the web app. EASA is a low-code platform designed to enable engineers and scientists to build web-apps with intuitive graphical user interfaces and simplified inputs and outputs, which then connects with a version-controlled instance of any model on a secure server. Within RomaxWIND, Romax engineers design the gearboxes and build an input XML file for each case, which contains the parameters that the user should be able to vary, the actions to process and the results required: this is the batch file. It is an editable structured text file that can be read by RomaxWIND, and corresponds to a complete analysis that can be run without any human interaction. RomaxWIND executes each step and writes the results in an output XML file similar to the input. Within the graphical user interface built with EASA, the user can choose the gearbox they want to analyse and load the duty cycle: rotational speed, torque, duration and temperature of each load case. Duty cycles can also be uploaded from pre-defined Excel Spreadsheets. Selecting the "run button" will calculate the results. The run triggers several actions: in the background, EASA calls another Excel Spreadsheet, fills some of its input data cells (such as the path to the input XML file and the duty cycle table) and activates its macros. Afterwards, it reads the results displayed in the Excel spreadsheet and displays them in the graphical user interface. By executing this analysis on several gearboxes and based on the calculated damage and life of the components, the user can quickly determine which gearbox best fits their needs.

Presenter Name: May, Nathanael

Presenter Company: GrafTech International Holdings Inc.

Presentation Title: Modeling and Digital Image Correlation of Crack Growth in Graphite Electrodes (N. May, GrafTech International Holdings Inc.; Lvl: 2)

Type: Presentation

Keywords: Graphite, Electrode, Cohesive Zone Debonding, Fracture Mechanics, Electric Arc Furnace, Steel, Finite Element Modelling, COMSOL Multiphysics

Session Title: Multiphysics 4

Session #: 3-3

Room #: 21

Abstract:

Graphite electrodes are used in Electric Arc Furnaces (EAF) to re-melt scrap steel into new stock. These graphite electrodes are consumed during operation due to a combination of high temperatures and oxygen reacting with the graphite. However, they are also consumed due to breaks from a variety of causes. Understanding the causes and mechanisms of these breaks can help us to design electrodes which last longer, ultimately reducing the cost of recycling steel. GrafTech uses data from a mode 1 fracture test to study and control the fracture properties of graphite electrodes. In the test, a crack is forced to grow through a predefined zone, and then both the work of fracture and fracture toughness of the material are calculated. However, the scale of the test (several inches) and the scale of the full electrodes (several meters long) differ meaningfully. Furthermore, electrode graphite properties show significant anisotropy, complicating the relationship between test results and real electrode performance. Several models exist to translate these test results into material properties which apply to full electrodes in application, but simple calculations only offer limited predictive power. To improve this predictive power, a combination of physical testing, digital image correlation (DIC), and computer simulation together create a powerful package for understanding, predicting and controlling fracture behaviour in graphite electrodes. GrafTech uses digital image correlation to capture crack growth and material deformation of the test specimen in real time to supplement force/displacement data of traditional testing. Then, we use a 3D finite element model of the test itself to compare to the test and DIC data. This allows us to evaluate the predictive power of the various fracture and crack growth models for graphite, and calibrate both the model and graphite material properties to match our test results. Finally, a 3D model of the full electrode allows us to use the calibrated fracture model and properties to simulate and predict fracture and crack growth in application. Both of these finite element models, made in COMSOL, uses cohesive zone debonding physics to simulate crack growth. Together, these tools take us from small-scale lab tests, to a greater understanding of how furnace operating parameters and electrode design can decrease electrode consumption and thereby decrease costs for EAF operators.

Presenter Name: McLeod, Mike

Presenter Company: Accuride Corporation

Presentation Title: Democratization History at Accuride (M. McLeod, Accuride Corporation; Lvl: 1)

Type: Presentation

Keywords: Lessons, Learned, FEA, Wheel, DIY, Ansys

Session Title: Democratization 1

Session #: 1-1

Room #: 23

Abstract:

The term “Simulation Democratization” is a term that is misunderstood by many even though the concept has been around for several decades. Within the context of this presentation, “Simulation Democratization” will mean the bundling and automation of processes for evaluating and predicting the fatigue performance of commercial truck wheels at Accuride Corporation. Accuride is a leading North American manufacturer of commercial steel and aluminum wheels for vehicles like tractor trailers. For commercial wheels significantly more emphasis is placed on durability and design efficiency than on the styling that is seen in automotive applications. To achieve highly efficient designs Accuride relies strongly on engineering analysis methods. The author’s 20+ years of experience with Accuride provides lessons learned from five different simulation democratization efforts dating back to 1996. The justification for each democratization effort has always been the same. The objective has been the need to lower costs, weight, and time to market while increasing (or maintaining) durability and margin standards. To achieve this object the product development tools need to be more accurate, flexible, realistic, and efficient. In 1996 Accuride undertook a democratization effort to create an Instant Design and Engineering Analysis by the year 2000. This was better known as IDEA2000. IDEA2000 prompted the user for the desired wheel parameter and then tried to automatically create a CAD model and associated FEA model to meet the criteria. The program was supposed to iterate to achieve the “optimal” design. While IDEA-2000 was being implemented and interim democratization approach was developed using the same CAD and FEA system. A macro based approach following the FEA modeling process was created. A series of macros allows improved efficiency in the modeling process. Based on the lessons learned from IDEA2000 and the macro based system a new semi-automated design tool was created to take CAD input with design parameters to automatically perform the engineering analysis and provide a summary report for each analysis. This democratization effort was labeled AccuFast and was highly successful. Up through the implementation of AccuFast all FEA modeling was done using linear FEA methods. The need to increase model fidelity saw more analyses requiring nonlinear analysis method to handle contact, plasticity, and bolt loading. The FEA modeling process shifted back to manual a method but using much more user friendly interfaces than existed years earlier. As the software user interfaces improved it became possible to build model templates that included all the model definition except geometry. Changing geometry and updating a model was about 80% effective. The current democratization approach is an expansion of the template models except that there is no initial template. Using Python programming with access to the FEA software database the “template” is created after the user inputs design parameters. By using custom python scripts programming logic can be used to evaluate geometry and create individual analysis models. Existing software capabilities can be used or new ones can be created. A summary of lessons from the various democratization attempts is provided including which efforts were considered more successful. Democratization efforts can be expensive and time consuming to implement. Knowing some of the pitfalls and keys to success will increase the chances for future high returns on investment of democratization programs.

Presenter Name: Meintjes, Keith

Presenter Company: CIMdata Inc

Presentation Title: Optimization: From Generative to Human-Assisted Design, and Machine Learning (K. Meintjes, CIMdata Inc; Lvl: 2)

Type: Presentation

Keywords: Optimization, Generative Design

Session Title: Advanced Information Technologies

Session #: 3-3

Room #: 25A

Abstract:

Note: This abstract is submitted as a suggestion for a paper, or as a theme-setting introduction to a Conference session. For millenia, up until the last 150 years or so, the only way to evaluate a design was to build and test it. Henry Petroski ("To Engineer is Human") tells it very well, how the British developed iron railroad bridges. Quite simply, they changed the design until the bridges stopped falling down. (https://en.wikipedia.org/wiki/Henry_Petroski) Then we see the rise of analytical methods that helped with the design, and even allowed evaluation of proposed designs. This is digital prototyping, like we have seen with finite-element analysis for the last sixty years or so. But now, we have something different. Generative Design is able to take statements of product requirements and transform them into designs (shape, materials, and configurations) in ways that unaided humans cannot. There is conceptually no need to confirm the design, for the design process itself ensures the requirements have been met. Generative design will be at the nexus of optimization, materials engineering, and new manufacturing methods like additive manufacturing. One also believes that I am being too brief, and I need to add more words here. Now, the idea is we can add machine learning to the process, to do what some call "Human-Assisted Design". Here, the human is an orchestrator, the conductor, making choices from machine-generated design options. As people like Ted Blacker will eloquently tell you, this will enable innovation in ways we cannot imagine. To me, this is the important point. We are moving from evaluating proposed designs to directly creating capable designs. A unified way to think of such methods is Optimization. These methods modify (or even create) a design based on requirements. If one then adds the layer of machine learning or artificial intelligence, I believe we are on the verge of a profound revolution in product design and engineering.

Presenter Name: Mitchell, Richard

Presenter Company: ANSYS Inc.

Presentation Title: GPU Technology in the Cloud for Scalable and Democratized Engineering Simulations (R. Mitchell, ANSYS Inc.; Lvl:)

Type: Presentation

Keywords: GPU, Cloud, Democratization

Session Title: Democratization 1

Session #: 1-1

Room #: 23

Abstract:

The simulation community is realizing the potential of the latest Graphical Processing Unit (GPU) technology to provide significant acceleration to engineering design workflows. The increasing availability of CPU cores is well known and more and more CAE codes are highly parallelized and making use of multiple cores with great success. GPU technology offers up even more compute resources with thousands of additional cores available for more efficient computation and reduced job run times. GPU technology has proven effective at speeding up certain complex CAE problems, but determining which workflows and algorithms will benefit the most from this technology can be challenging. This often requires experimentation with combinations of solver technology, model configuration, and combined GPU + CPU architecture configurations. For the end user, the latter can be difficult to access and alter, as on-premise compute infrastructure options are typically limited and costly to update. While compute power has increased a thousand-fold over the last decade, the cost of hardware has also decreased and large-scale computing is now within reach of most engineering teams, particularly those with access to cloud computing. Cloud computing is increasingly being explored by organizations as a cost-effective, highly scalable and on-demand addition to on-premises high-performance computing resources. By accessing the latest generation of GPUs on a cloud platform, engineering teams can experiment with these new architectures immediately and accelerate their multi-physics simulations without a large upfront capital expenditure investment. This platform would provide users the compute stack required to benchmark CAE software on GPUs and allows end users to send jobs immediately to the cloud. Post-processing of data can also be run on cloud minimizing data transfer requirements. By making use of cloud computing resources, organizations can mitigate the combinatorial challenges of configuration optimization while addressing hardware obsolescence at low capital expenditure. The vast variety of available architectures, including those with GPU on the cloud, allow engineers to perform CAE workloads on the best suited hardware.

Presenter Name: Morra, Ed

Presenter Company: Orthopaedic Research Laboratories

Presentation Title: Virtual Testing of Total Knee Arthroplasty Component Performance (E. Morra, Orthopaedic Research Laboratories; Lvl: 1)

Type: Presentation

Keywords: Non linear, finite element, multi body, kinematic, musculo skeletal, contact, ADAMS, MARC

Session Title: Medical Devices 3

Session #: 3-1

Room #: 26B

Abstract:

Manufacturers and regulatory agencies share a common goal of having safe and effective total knee arthroplasty (TKA) products available in the global marketplace. Several methods of testing TKA designs, inclusive of virtual computational models and physical laboratory wear test simulations, are employed to predict polymer tibial insert damage patterns. However, the latter is criticized for poor clinical correlation, long testing times, large expense and the difficulty in providing meaningful comparisons with other clinically successful designs. Thus, virtual testing is finding an increasing role in defining TKA performance in clinical orthopedics. The virtual test methods described in this presentation are able to discern differences in performance between TKA designs, are faster and less expensive than physical methods, solve the contemporary problem of obtaining predicate designs for comparison and have been accepted by the US Food and Drug Administration as evidence of safety and effectiveness for pre-clinical product testing. Computational estimates of short and long term clinical performance of a large variety of artificial knee designs are obtained using non linear finite element and multibody kinematic modeling tools, both employing sophisticated component contact algorithms. Measures of component longevity (polymer bearing component stress and dynamic wear paths) and patient satisfaction (range of knee flexion and joint stability) are directly comparable between new designs and those with successful clinical histories. Computational finite element and kinematic modeling tools offer an effective alternative for predicting the in-vivo performance of TKA designs. The computational results compare favorably to industry and regulatory agency accepted evidences of contact areas and stress measurements, laboratory wear simulation, clinical range of motion and worn component retrievals. These validated tools are also most useful in the product development stage to vet design concepts computationally, prior to the time and expense required for prototype production and subsequent physical laboratory testing. A large database of results is publicly available at http://orl-inc.com.

Presenter Name: Morrison, Tina

Presenter Company: US Department of Health & Human Sciences

Presentation Title: Priorities Advancing Regulatory Science and In Silico Medicine at the FDA (T. Morrison, US Department of Health & Human Sciences; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 3

Room #: Grand Ballroom B

Abstract:

Presenter Name: Mudigonda Kuravi, Girish Kalyan

Presenter Company: Altair Engineering Inc.

Presentation Title: Reducing Engine Block Bore Distortion Using Topology Optimization (G. Mudigonda Kuravi, Altair Engineering Inc.; Lvl: 1)

Type: Presentation

Keywords: Optimization, topology, distortion, engine block, engine, block,

Session Title: Optimization 4

Session #: 3-3

Room #: 26A

Abstract:

Reducing Engine Block Bore Distortion using Topology Optimization Themes & Topics: Optimization Abstract With the current CAFÉ standards set by the federal government, OEM's are working towards reducing the energy consumption of the vehicles. One of the ways to achieve it is by improving the performance of the engine to improve the fuel economy and the emissions by a vehicle. Cylinder bore distortion is one of the factors that influence the fuel economy of a vehicle. Reducing cylinder bore distortion can significantly improve the performance of the engine. A cylinder bore distortion can cause increased friction between the cylinder bore and the pistons. This increased friction can drop the efficiency and performance of the engine. It reduces the overall life of the engine, causes an increase in the oil consumption, can also cause vibration and acoustics issues. Since cylinder bore distortion has a huge impact on the performance of the engine, it is important to address this issue early in the design life cycle. Cylinder bore distortion can be caused by a number of loads on the engine head and block including bolt pretension and press fit during the assembly stage and the firing loads during engine operation. It is important not only to evaluate the cylinder bore distortion throughout the design life cycle but also to optimize the engine block to reduce these distortions. This study talks about evaluating various orders of Bore Distortion from the displacement results associated with the grid points of the bore surface. The displacements are captured for all the assembly and operating load cases. The distortion orders are determined by representing the bore deformation profile by means of a Fourier series and evaluating the Fourier series using the fast Fourier transform (FFT). This study also talks about performing topology optimization to create ribs on the outside of the engine block to reduce these distortions from various orders. Name: Girish Mudigonda Job Title: Application Specialist E-mail ID: girishm@altair.com Phone No.: 248-813-7707

Presenter Name: Mukherjee, Siddhartha

Presenter Company: ANSYS Inc.

Presentation Title: 3D Automatic Mesh Nonlinear Adaptivity (NLAD) Using Quadratic Tetrahedral Elements (S. Mukherjee, ANSYS Inc.; Lvl: 3)

Type: Presentation

Keywords: Nonlinear Finite Element Analysis, Adaptive simulation, Remeshing, Material models

Session Title: Nonlinear

Session #: 2-1

Room #: 25C

Abstract:

Real life industrial problems like elastomeric seal fitting or metal forming often undergo large scale nonlinear behavior during fabrication and/or application of operational loads. The nonlinearity usually arises due to material properties (hyper-elastic, elastoplastic, viscoelastic, visco-plastic etc.), geometric behavior (large displacements, rotations, strains) and establishment or separation of contact (frictional, non-frictional, bonded) among other effects. ANSYS Mechanical has a suite of meshing tools, efficient elements, nonlinear material models, contact capabilities and solvers to simulate and solve these problems with accurate representation of the nonlinearities. Solution of such problems using implicit FEA algorithms in a Lagrangian framework necessitates global equilibrium at each 'time step' (i.e. load 'substep' in a quasi-static framework) to lend reliability to the results. However, as the solution progresses with increasing loading, the elements change in size and distort; this leads to inaccuracy in results and loss of convergence. The ANSYS NLAD feature addresses this issue by automatically refining and/or remeshing the distorted parts of the mesh based on certain user-defined criteria and progressing with the solution. In general, NLAD changes element size distribution (for accuracy) and remeshes (ensuring convergence and solvability). The 3D NLAD capability in ANSYS was introduced in V16.0 with 4-node, pressure stabilized, linear tetrahedron elements (SOLID285). However, problems with geometries with sharp local curvature can adequately be modeled with planar facets only with a very large number of elements. Also, as the deformation of the material progresses with the load, regions of high local curvatures develop which linear elements cannot represent adequately. As a specific case, contact surface evolution with linear facets bring convergence difficulties as gaps and penetrations also increase and evolve – as seen often in elastoplastic metal forging simulations. This is the motivation behind the development of the NLAD with higher order tetrahedra (10 node SOLID187). This element supports pure displacement, constant hydrostatic pressure-mixed (for hyperelastic materials) and linear hydrostatic pressure-mixed formulations (for nearly incompressible elastoplasticity). In addition, surface to surface contact elements (CONTA173 and CONTA174) are also supported with both pure penalty and augmented Lagrange formulations. The NLAD procedure is completely automatic and requires no user input during solution. The user is responsible for specifying certain criteria (rules which determine whether mesh requires any change and the locations where it should change). The criteria are automatically linked to the type of mesh modification algorithm. Criteria based on contact status, local region (i.e. 'box') and strain energy, if specified – will automatically locally modify the element size distribution to ensure that the criteria are satisfied. This is done primarily to enhance accuracy of the solution. Mesh quality based criteria, if specified, will automatically repair the distorted mesh to ensure solvability and solution convergence. Once the solid element mesh is modified, all relevant contact, target and surface elements are also automatically generated. All boundary conditions and loads are recalculated automatically for the new parts of the mesh. Next, all element based solution variables (for both solid and contact elements) are mapped automatically – taking into consideration the dependence of the individual mapped fields which is necessary for convergence. Subsequently, the solver is triggered automatically and the solution progresses. Fault tolerance is built into the system to automatically reject new meshes which do not satisfy the criteria. Both Shared Memory Parallel (SMP) and Distributed Memory Parallel (DMP) solution approaches are supported, so very large-scale problems can be solved.

Presenter Name: Murphy, Cynde

Presenter Company: Adaptive Corporation

Presentation Title: Dynamic Load Calculation and Correlation of Aluminum Truck Body for Knapheide Mfg Co. (C. Murphy, Adaptive Corporation; Lvl: 2)

Type: Presentation

Keywords: FEM, Load Recovery, Fatigue, True-Load, Structure, truck, Finite Element Analysis, Abaqus, Strain, Strain gage

Session Title: Real-Time Simulation

Session #: 3-2

Room #: 26B

Abstract:

Analytical simulation is a powerful tool that can allow for understanding the dynamic behavior and fatigue life of any structure. However, one of the most challenging tasks involved with developing a simulation is developing accurate and realistic load cases that replicate field strains in the structure. Once a representative finite element model (FEM) of a structure is created, challenges arise when understanding and applying dynamic loads to the FEM so that correlation and validation with physical testing is accurate. One step further in complexity is being able to calculate dynamic stress profiles for the entire structure, and use those results for further investigation such as fatigue estimates. Historically, analysts have had to rely on expensive prototyping and time-consuming full vehicle measurements, even within the iterations of one design concept. Analyze-Build-Test is quickly becoming a thing of the past, as product development companies strive for quick to market designs. Simulation experts at Adaptive Corporation, in conjunction with Knapheide, were able to circumvent this traditionally laborious process and develop an efficient and accurate process. Our team has leveraged the use of ANSA, ABAQUS, Wolf Star Technologies True-Load™ software and Fe-Safe, to develop an FEM, understand the dynamic mechanical loads and develop a duty cycle for their truck body structure. This body of work can and will be subsequently used for design, simulation, fatigue analysis and engineering development of iterations of the same structure, as well as similar truck body structures. The general steps of the process are as follows: FEM Creation of Structure FEM of the structure was created using ANSA pre-processor software. Instrumentation and Data Acquisition To successfully calculate mechanical loads acting on the Knapheide truck body structure for the FEM, accurate strain measurements were required. Using the FEM and the Wolf Star Technologies True-Load™ software, optimal strain gages placement was identified and installed on a (prototype) truck body structure. Strain gage time history data for various proving ground events, such as cornering, bump tracks, rough terrain, was acquired. Load Calculation and Development Using the time history data for the optimal map of strain gages, the FEM and True-Load™ software, equivalent (dynamic) unit loads were calculated. Fatigue Analysis Using dynamic stress results from the FEM, given a duty cycle that included a combination of various proving ground events, fatigue life estimates of the truck body structure and critical welds were calculated. Calculating the mechanical loads for this project allows Knapheide the ability to rapidly iterate on designs for this truck body structure, as well as provide a starting point for other similar truck body designs. This ultimately saves time and money in their product development cycle by eliminating the entire design-build-test cycle.

Presenter Name: Nagy, Dennis

Presenter Company: BeyondCAE

Presentation Title: The Emerging Key Role of Simulation in the Full Product Performance Lifecycle (PPL) (D. Nagy, BeyondCAE; Lvl: 2)

Type: Presentation

Keywords: digital twins, product performance lifecycle (PPL), IoT, sensors, automated simulation

Session Title: Full Product Performance Lifecycle (PPL)

Session #: 2-3

Room #: 25A

Abstract:

Engineering Simulation (CAE) has grown from a niche trouble-shooting (1980s) and design verification technology (1990s) to become a mainstream part of engineering development in the 2000s in most major technology-driven product industries, led by automotive and aerospace but broadening to energy, medical, comsumer product industries and more over the past two decades. Other than the very early use for trouble-shooting of in-field performance problems, CAE has overwhelmingly become a technology that is focussed up-front on improving product design and development. With the advances in simulation software algorithms and data structures, coupled with dramatic reductions in cost of high-perfomance computing (HPC) and ease of affordable access (e.g., cloud-based, "by the drink"), CAE has now become the practical, affordable foundation for design-space exploration and optimization, but still in the development stage of a product's lifecycle. Driving the use of CAE and system models as key business benefit enablers throughout the full performance lifecycle of products and systems (PPL) opens up a whole new “order of magnitude” increase in the use of engineering simulation beyond just the traditional design/development phases. Automated simulation apps that link continuously-updated (field modifications, damage, corrosion,...) robust digital-twin simulation models to ongoing real-time product/system performance data, from sensors and other lifecycle input, provide the emerging basis for engineering simulation to be the key engine in real-time feedback for improved ongoing system operation. This area of dramatically-increasing engineering simulation usage will come without necessarily the corresponding need for a dramatic increase in the number of traditionally trained and experienced simulation engineers. The key focus will be on having enough trained/experienced engineers and developers creating, maintaining, and enhancing the up-front automated PPL hardware-software systems necessary to drive simulation-based lifecycle feedback for enhanced product/system performance and resulting business benefit. An excellent early example of this potential by SAP/Fedem can be seen at http://schnitgercorp.com/2017/05/22/fedem-hits-stage-front-30000-sapphire/. This presentation will cover recent work on simulation-oriented digital twins by a number of software vendors and end-user organizations. The SAP/Fedem example will be shown and discussed in some detail as well as other examples that emerge publicly prior to the June 2018 CAASE event.

Presenter Name: Nandi, Biswanath

Presenter Company: Dassault Systèmes SIMULIA Corp

Presentation Title: A New Multiphysics Technology for Tire Hydroplaning Simulations (B. Nandi, Dassault Systèmes SIMULIA Corp; Lvl: 3)

Type: Presentation

Keywords: Hydroplaning, Co-simulation, FSI, Lattice-Boltzmann Method,CFD

Session Title: Multiphysics 1

Session #: 2-2

Room #: 25C

Abstract:

Predicting hydroplaning velocity of a particular tire is very important for the tire manufacturers as it is a safety criterion. Tire hydroplaning is a complex Fluid-Structure Interaction (FSI) problem because it involves interaction between a deformable and rolling tire with its surrounding water. Many commercial finite element codes have been used for solving this challenging problem. This paper focusses on investigating a new co-simulation technique between Abaqus/Explicit and XFlow, a Lattice-Boltzmann Method (LBM) CFD code. Co-simulation is a segregate solution technique where the fluid and solid domains are solved separately. The deformable tire is modeled in Abaqus/Explicit, and the water is modeled in XFlow. In the co-simulation, information exchanges occur though the contact surface between the tire and the water. Abaqus passes the deformed nodal coordinates and the nodal velocities to XFlow, and XFlow computes the hydrodynamic concentrated forces induced by the water and passes those back to Abaqus. The LBM is a relatively new technique in the CFD domain but attracting more attention from the industry and the academia. The LBM changes the angle of attack of a fluid flow phenomenon from the macroscopic level governed by the Navier-Stokes equations to a mesoscopic one, where the fluid is idealized as populations of fictitious particles colliding and streaming along the different links of a discrete Cartesian lattice. Among its most attractive features, one is certainly represented by the algorithmic simplicity of the collide-and stream process. This paper describes the steps of setting up a hydroplaning co-simulation correctly and also documents the best modeling practices to achieve meaningful results. Firstly, the paper verifies the co-simulation technique with some simple academic problems. The Coupled-Eulerian Lagrangian (CEL) technique available within Abaqus/Explicit was introduced several years back and has been used also for simulating hydroplaning phenomenon. This paper also compares the results and the performance between these two techniques.

Presenter Name: Narayanan, Vijay

Presenter Company: Siemens PLM Software

Presentation Title: Contact Assembly Sequence Modeling (V. Narayanan, Siemens PLM Software; Lvl: 2)

Type: Presentation

Keywords: Contact Mechanics; Finite Elements; Mortar Methods; Patch Test; Assembly Sequence Modelling, Bonded Contact, Rough Contact, No-Separation Contact, Bolt, Cyclic Symmetry, Plasticity

Session Title: Contact, Joints, Welds & Connections 1

Session #: 1-1

Room #: 25C

Abstract:

CONTACT ASSEMBLY SEQUENCE MODELING Vijay Narayanan, Jim Bernard Numerical simulation of contact problems using finite elements plays an important role in a vast array of engineering applications such as in aerospace, automotive, locomotive and shipbuilding industries etc. Variables such as friction, large deformations, finite sliding, plasticity and wear introduce additional complexities that call for stable, robust, accurate yet efficient solutions to contact problems. In recent years there has been a growing need for integrating complex subsystems and assemblies thanks to advancements in computing, meshing and solver technologies. These individual components from different vendors are typically meshed independent of one another and need to be assembled together using interactions such as contact or special cases of contact like bonded or sliding or rough behavior. Many times, these contact interactions are created and introduced sequentially in an analysis to simulate press fits or in conjunction with bolt preloads. In this regard, the following types of contact are considered: 1. Standard contact: General segment-segment contact algorithm with or without friction. 2. Rough Contact: Similar to standard contact but does not allow sliding by assuming infinite friction. 3. Bonded/Tied Contact: Weld like behavior with no relative displacement in normal and tangential directions. 4. No-Separation Contact: Frictionless free to slide formulation where there can be no relative displacement only in the normal gap direction. The contact formulation for all the interface types described above is implemented as a segment-segment method involving a surface refinement approach similar to that of a mortar based methods. This algorithm passes the constant stress patch test and produces excellent quality of contact stress results across the interface. An example model showing a simplified representation of several components of an axial gas turbine is presented. The individual components are connected through standard, rough and bonded contact types. The analysis sequence is carried out in a multi-step process alternating between press fits and bolt tightening. Once assembled, structural loads are introduced in additional steps. Cyclic modes are solved at intermediate points as linear perturbations taking into account differential stiffness from prior static load steps. Finally the bolts are unloaded sequentially to study any residual plastic deformations in the model.

Presenter Name: Narayanan, Vijay

Presenter Company: Siemens PLM Software

Presentation Title: Bolt Preload Modeling Methods (V. Narayanan, Siemens PLM Software; Lvl: 2)

Type: Presentation

Keywords: bolt, preload, pretension, bolted joints, contact, initial strain, cut section, beam, bar

Session Title: Contact, Joints, Welds & Connections 2

Session #: 1-2

Room #: 25C

Abstract:

Preloaded bolts are used in finite element analysis to model the behavior of two or more parts being held together while undergoing mechanical, thermal or other loading conditions. Such a modeling scenario typically requires the bolts to be preloaded to a specified value and a set of contact regions to be established between the parts held together by the bolt. This is done by either specifying a load or a bolt shortening. The resulting preload can be identified by studying the internal forces within the bolt shaft or by the contact forces between the various parts that are held together. The bolt preloading approach that currently exists in various commercial solvers involves defining beams or solid elements that form the bolt shaft and specifying a location where the solver cuts the model perpendicular to the bolt axial direction. The requested load or a shortening is applied axially on either side of the cut in opposite directions while reducing the axial stiffness along the bolt axial direction. This causes the part to shorten whereby each cut plane penetrates the other resulting in a tension that equals the requested preload. This method of preloading bolts is well-known to finite element users and has a high degree of accuracy and reliability. An alternate approach to preload bolts is presented here wherein the preload or shortening is applied as an initial strain along the bolt. Here, the user selects a set of elements that form the bolt shaft along with a bolt axial direction. Numerically, the user defined preload is applied as an initial strain on the selected elements and does not require the shaft to be cut. The resulting initial strain may need to be iterated upon until the internal forces in the bolt elements match the user requested preload. Comparison of the cut approach and the initial strain approach results will be presented. Realistic model showing application of the initial strain method will also be presented.

Presenter Name: Nigge, Karl-Michael

Presenter Company: Volume Graphics GmbH

Presentation Title: Micromechanics Simulation Directly on CT Scans (K. Nigge, Volume Graphics GmbH; Lvl: 1)

Type: Presentation

Keywords: Micromechanics simulation, mesh-free, computed tomography, complex materials, hybrid materials, bionic optimization, additive manufacturing

Session Title: Advanced Materials Characterization

Session #: 1-2

Room #: 25A

Abstract:

Lightweight design has initiated a trend towards more complex materials such as fiber compounds, porous metals or ceramics and hybrid materials such as metal-metal laminates. At the component level, lightweight design increasingly leads to complex shapes resulting from bionic optimization which can only be produced by 3D printing, casting or injection molding. Their mechanical properties may be sensitive to defects such as porosity which are inherent in these production methods. As a consequence, there is an increased need for micromechanics simulations to determine the effective mechanical properties of complex materials and to assess the mechanical strength of components with optimized shapes and internal defects. Classical FEM simulations may not always be well suited to address these problems because they require the generation of geometry conforming meshes which must be fine enough to capture all relevant geometric details on the one hand, but coarse enough to keep the computational effort at a practical level on the other hand. Furthermore, the mesh cells must conform to certain shape criteria in order to assure the numerical stability of the simulation. Recently, mesh-less and immersed-boundary finite element methods have been used to overcome the meshing problem. Such methods do not require the generation of a boundary-conforming mesh and are suited for the simulation of arbitrarily complex domains. This approach is implemented in the Structural Mechanics Simulation module of VGSTUDIO MAX by Volume Graphics and works directly on CT scans which accurately represent internal discontinuities as well as complex material structures and outer shapes. In order to validate this simulation approach, a comparison between experimental and simulated results of tensile tests was conducted for two types of additively manufactured AlSi10Mg components, a tension rod and a bionically optimized aeronautic structural bracket, showing a good correlation between the predicted and measured tensile strengths and the locations of the first crack occurrences. The approach was also validated against a classical FEM simulation for a solid cube and a cubic lattice made from Ti6Al4V, with the results of the two methods being in good agreement. The simulation approach presented here can be used to determine the effective mechanical properties of new materials with inherently complex internal structures. For manufactured components, it can be used in both R&D and quality assurance to determine the influence of defects or shape deviations on the mechanical stability. This can be done by simulating the internal stress distributions for both a CAD model of the ideal component and CT scans of prototypes or manufactured parts and comparing their respective hotspots. In such comparisons, the tolerancing criterion for the actual components is that defects or shape deviations must not lead to local stress peaks which are significantly higher than those found in the ideal component.

Presenter Name: Noll, Scott

Presenter Company: The Ohio State University

Presentation Title: Challenges and Rewards of Integrating Computer Aided Engineering in Undergraduate Engineering Experience (S. Noll, The Ohio State University; Lvl:)

Type: Presentation

Keywords: CAE, training, universities,

Session Title: Simulation Governance: Qualification of Simulation Personnel

Session #: 3-3

Room #: 23

Abstract:

Computer-Aided Engineering (CAE) software has made considerable strides in streamlining the user interfaces of highly complex analysis tools. By doing so, it is far more available to those who are not “experts” in the field, and there is great potential for CAE to be used as both a learning and engineering tool. As much as pilots spend countless flight-training hours in simulators, undergraduate engineering students can benefit similarly through learning how to use CAE tools with continuous practice. Traditionally, academia’s role in preparing students for CAE is limited to specific courses that present the foundational theoretical concepts on which commercially available codes. These courses, typically offered at the graduate level, perpetuate the misconception that the use of CAE tools requires graduate coursework and complex coding skills. It is a difficult challenge for academia to integrate simulation courses, as there is no time due to accreditation or workload considerations. However, there is a clear industry need as large-scale simulation programs are commonly used for research and development. There is a continual push for shorter development cycles and the need for simulation has continued to increase; thus, future designs will emphasize more digital models and fewer prototypes. At The Ohio State University, we have developed two approaches to introduce simulation in the undergraduate experience in an innovative manner. The first approach is through a formal course requirement, the senior capstone course. In engineering, senior capstone courses are comprised of 6 credit hours over two semesters and are typically completed during the final year of the undergraduate curriculum. The project objectives are designed to match the skills of senior undergraduate students. The students are then tasked to solve an engineering problem utilizing modern CAE software and testing tools. The students are mentored by Center CAE experts and are reviewed periodically by industry mentors. Finally, the students are tasked with preparing a written report and final presentation to the industry partner representative. The second approach is a Center-based undergraduate internship program. The interns are typically ready for an internship during their 2nd or 3rd year in the undergraduate program. After the interns are matched with a sponsoring company, the intern will start at the sponsoring company. When the intern returns to campus, OSU collaborates with the industry sponsor to provide access to the needed resources to successfully complete the project. While at OSU, SIMCenter research scientists will mentor the intern on the assigned project. After the intern graduates, the company has the opportunity to hire the well-trained new graduate. Overall, the outcomes for both approaches have been very positive from both the perspectives of the student as well as the industry partners. This presentation will further review typical internship and CAE capstone projects, the tools employed, challenges encountered during implementation of each program and feedback from both student and industry partners.

Presenter Name: Novak, Luke

Presenter Company: Fisher Controls International LLC

Presentation Title: Confidence and Sensitivity of CFD Predictions of Control Valve Capacity (L. Novak, Fisher Controls International LLC; Lvl: 2)

Type: Presentation

Keywords: CFD, Meshing, Turbulence Models, Validation

Session Title: CFD 1

Session #: 1-1

Room #: 26A

Abstract:

The growing trend of simulation democratization and utilization of Computational Fluid Dynamics (CFD) by non-expert analysts has come with the promise of enabling reduced product development time and cost by providing insights key to making design choices earlier in the development process. While this is an understandably attractive proposition, this trend also elevates the level of concerns and risks associated with the potentially negative impacts from the generation, interpretation, and application of CFD simulations by non-experts, especially using non-validate methodologies. The proliferation of results generated using non-validated CFD methodologies may have serious consequences on design decisions, which may more than offset the initial benefit in project schedule and cost when test results or more detailed and validation simulations are performed with unexpected results. For some control valve designs, it has been observed that seemingly trivial changes to meshing inputs can result in unexpectedly large effects on valve capacity predictions. This sensitivity to small input changes is further magnified by the selection of and coupling with an appropriate turbulence model for massively separated and complex recirculating flows. In light of these observations, the importance of validating CFD simulation methodology against test results and the involvement of analysts with suitable competency in the simulation workflow to assist in assuring the quality of results is highlighted. Real-world examples of these unexpected sensitivities are explored, along with a discussion of their potential impacts if validation efforts had not been pursued. If non-validated CFD methodologies are employed early in the design cycle, the expected benefits may not be realized due to unquantified or uncharacterized deficiencies in the method. In contrast to CFD analysis tools where these modeling and meshing choices are typically made behind the scenes without any user involvement or awareness, the presented approach uncovers unexpected modeling sensitivities and poor assumptions before these issues can drive a design process down a path of unnecessary costs and schedule delays.

Presenter Name: Noviello, Daniel

Presenter Company: Autodesk Ltd.

Presentation Title: Understanding Additive Manufactured Lattice Structures with Explicit Dynamics and Testing (D. Noviello, Autodesk Ltd.; Lvl: 2)

Type: Presentation

Keywords: explicit dynamics, additive manufacturing, lattice, tensile test, failure prediction, element deletion

Session Title: Analysis & Certification of 3D Printed Parts

Session #: 1-3

Room #: 25B

Abstract:

Metal additive manufactured (AM) lattice-type structures are an efficient way of establishing high directional stiffness at a far reduced material volume. This makes them ideal for aerospace applications such as UAVs. Typical manufacturing processes include SLM (Selective Laser Melting) / DMLS (Direct Metal Laser Sintering), and EBM (Electron Beam Melting). When considering real-life applications of these structures, many assumptions are made about the characteristics of the manufactured material. Among others, these include strength, elastic moduli, thermal properties, material density, surface finish, and structural stability. These characteristics are affected by many factors, including laser spot size, laser power, metal powder, build orientation, and feature size. This paper addresses some of the key problems with characterizing metal AM parts. Specifically investigated are how bulk material properties correlate with lattice feature size (sub 1mm), and why this occurs. Explicit dynamics finite element simulations are used in a novel quasi-static regime to predict the deformations and failure. These simulations are applied to the microscopic features of tensile specimens using 3D models obtained via CT scans. This enables very close observation of the initiation and completion of ductile fractures. Comparisons are drawn between the simulated fractures and the actual test fractures. Next considered are methods of physically testing the stiffness and strength of built-up lattice structures. Using the material data obtained from size correlated dog-bone specimens, the lattices are simulated with explicit dynamics and self-contact. Observations are made of progressive failure modes for lattices in both tension and compression, and subsequently correlated to the simulations. The load-displacement behavior is also directly correlated to test and shows good accuracy. The study ultimately presents a method whereby a metal AM lattice can be reliably simulated despite aggressive idealization of the features. The correlation of bulk material properties with AM lattice feature size shows that the properties change at smaller sizes, but become constant at larger sizes. The benefits of using explicit dynamics are explored, particularly for predicting ductile fracture surfaces, and problems with complex contact.

Presenter Name: Noviello, Daniel

Presenter Company: Autodesk Ltd.

Presentation Title: Design-Build-Test: Closing the Loop on Generative Design + Additive Manufacturing (D. Noviello, Autodesk Ltd.; Lvl: 2)

Type: Presentation

Keywords: Additive, Manufacturing, Powder bed, Generative design, Validation, Test

Session Title: Product Design Based on Additive Manufacturing 3

Session #: 2-3

Room #: 25B

Abstract:

Consider the traditional design cycle; an engineering team takes a set of requirements like loads, constraints and form. It then designs a nominal structure that may or may not satisfy the requirements. This nominal structure is analyzed and then redesigned over several iterations until it meets the original requirements. This process takes a long time and is particularly laborious when requirements change mid-process. In the generative design workflow, the user inputs all requirements into the software. They also input design options like different materials, build orientations and safety factors. This allows the software to generate many designs that are fully analyzed. Instead of having to iterate and redesign, the engineer can navigate a range of designs for which all requirements have been met. Should requirements or specifications change, they can simply choose another design from the solution space. This paper considers the well known Alcoa-GrabCAD bracket challenge and applies the generative design workflow. One of the many potential options is taken from design, to build, to test, and fully verified with detailed non-linear finite element models. It is shown that the engineer can very accurately simulate the real mechanical behavior of these designs. The test method and test apparatus is described in detail with jig design etc. The method of correlation is fully described and the relevant challenges highlighted. Correlation is based on non-linear static models (geometric and material non-linearity). Comparisons are drawn between the mechanical performance of the original bracket and the generative design bracket. The efficiency of shape is shown to not only improve mass, but also ductility and strain to failure. Simulations are used to show redistribution of stresses in the plastic range. Nuances about additive versus subtractive materials are also explored. Finally in-service design, validation and verification recommendations are given. This relates to type of material and desired additive material properties.

Presenter Name: Nowinski Collens, Caralynn

Presenter Company: UI Labs

Presentation Title: Accelerating Innovation through Collaboration (C. Nowinski Collens, UI Labs; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 2

Room #: Grand Ballroom B

Abstract:

Digital tools are disrupting every industry, and how companies decide to work together to use these tools will separate the winners and the losers. Collaborative approaches among innovators, executives, end-users, customers, suppliers, and more are essential to solve the world's biggest problems - but this is easier said than done. Explore how organizations are leveraging advanced technologies to transform their industries through collaboration.

Presenter Name: Nutwell, Emily

Presenter Company: The Ohio State University

Presentation Title: The University's Role in Addressing the Skills Gap and Preparing Individuals for CAE: Continuous Learning and Workforce Development (E. Nutwell, The Ohio State University; Lvl: 1)

Type: Presentation

Keywords: Universities, workforce development, CAE

Session Title: Simulation Governance: Qualification of Simulation Personnel

Session #: 3-3

Room #: 23

Abstract:

In a global and fast paced economy, the movement towards an increasingly virtual development flow is driving a need for engineers who can implement computational tools effectively in order to drive down cost and development time while developing successful products. Currently, this need is largely being met by engineers who are specialists in their area of CAE (Computer Aided Engineering), but engineers who are not specialists must also gain competencies in these tools in order to adequately meet the needs of a virtual development flow. In the United States, engineers typically enter the workforce after earning an undergraduate degree, but it is recognized that an undergraduate education cannot cover the full spectrum of topics resulting in gaps in critical knowledge and skills. CAE at the undergraduate level is typically presented as a senior technical elective or possibly integrated into a Capstone project. Although a good first step, competency with any tool requires more exposure than an introduction and requires the opportunity to practice use of the tool in the context of projects and specific problem solving opportunities. Universities and industry have partnered in the past to facilitate continuing graduate education for engineers. Barriers such as cost, time, and transportation limit the number of workers that can participate in these programs to a select few. Presenting CAE in a certificate format allows universities to blend academic and practical considerations for CAE in a targeted and compact format specifically designed for the working professional. The level of commitment for these engineers is considerably more manageable than pursuing a full graduate degree, and the skills can be immediately applied into the workflow. This will strengthen university-industry partnerships by connecting faculty to industry partners, thereby promoting collaboration. This presentation will propose a certificate program concept for various engineering areas focusing on computational tools use such FEA, CFD, and systems control modelling. The program will be offered in a distance education format to reduce travel, time, and cost barriers for busy working engineers. Participants will be supported by university research staff who will be available to provide feedback and assessment of performance, and course material will be developed in a collaborative manner between research staff and faculty. The learning outcomes for this program will be for participants to gain experience in CAE tool use and application as well as to gain a fundamental understating of the theoretical concepts guiding the use of these tools. Since this program will be designed with the needs of the working engineer in mind, it can effectively address the skills gap currently being experienced and projected to continue to grow in the area of computer aided engineering.

Presenter Name: O'Flaherty, Kevin

Presenter Company: SmartUQ

Presentation Title: Uncertainty Quantification and Digital Engineering Applications in Design and Life Cycle Management (K. O'Flaherty, SmartUQ; Lvl: 2)

Type: Presentation

Keywords: SDM Implementation, life cycle management, uncertainty quantification, digital engineering, digital thread, Systems Simulation, Simulation Governance

Session Title: Simulation Governance: Data Management 2

Session #: 2-2

Room #: 24

Abstract:

Essentially every government and industry entity in the US Aerospace and Defense Industry, as well as numerous global industries, already have some form of ongoing digital engineering activity. The vision for implementation of digital engineering is to connect research, development, production, operations, and sustainment to improve the efficiencies, effectiveness, and affordability of processes over the life cycle of systems. Basic capabilities required of a model-based digital engineering approach to successfully achieve this vision are: • An end-to-end system model – ability to transfer knowledge upstream and downstream and from program to program • Application of reduced order response surfaces and probabilistic analyses to quantify uncertainty and risks in cost and performance at critical decision points • Single, authoritative digital representation of the system over the life cycle – the authoritative digital surrogate “truth source” This presentation illustrates both conceptual and practical applications of using Uncertainty Quantification (UQ) techniques to perform probabilistic analyses. The application of UQ techniques to the output from engineering analyses using model-based approaches is essential to providing critical decision-quality information at key decision points in a product’s life cycle. Approaches will be presented for the continued collection and application of UQ knowledge over each stage of a generalized life cycle framework covering system design, manufacture, and sustainment. The use of this approach allows engineers to quantify and reduce uncertainties systematically and provides decision makers with probabilistic assessments of performance, risk, and costs which are essential to critical decisions. As an illustration, a series of probabilistic analyses performed as part of the initial design of a turbine blade will be used to demonstrate the utility of UQ in identifying program risks and improving design quality. The application of UQ concepts to life cycle management will be addressed, highlighting the benefits to decision makers of having actionable engineering information throughout a system’s life cycle.

Presenter Name: O'Flaherty, Kevin

Presenter Company: SmartUQ

Presentation Title: Engineering Analytics for the Automotive Industry (K. O'Flaherty, SmartUQ; Lvl: 2)

Type: Presentation

Keywords: On board diagnostics, diagnostic trouble codes, model calibration, model validation, virtual sensors, real time prediction, vehicle telemetry, condition based maintenance

Session Title: Real-Time Simulation

Session #: 3-2

Room #: 26B

Abstract:

The complexity of today's automotive engineering systems increasingly requires analytics to extract useful information from simulation, testing, and recorded data. As system complexity increases and large test data sets become available, new challenges and opportunities emerge to use analytics to make more informed decisions. Engineering analytics becomes a necessity for fully realizing the benefits of creating detailed automotive models and collecting fleet wide data. For example, extremely detailed vehicle telemetry is now common and previously infeasible applications such as condition based maintenance and root cause analysis are questions of big data analysis. The process and results of using engineering analytics methods will be presented for three unique automotive applications in order to demonstrate the utility of performing advanced analytical techniques in a variety of scenarios. The engineering analytics solutions for these applications have been successfully tested on real industry challenges. The applications to be demonstrated are: 1. Analyzing Diagnostic Trouble Codes (DTCs) from On Board Diagnostics (OBDs) to characterize and build predictive models for the DTCs. Results include a predictive model for DTC as a function of mileage and a classification model to identify DTC indicator parameters. 2. Using statistical calibration to efficiently improve engine model accuracy. Results include a simulation model with improved accuracy, and a discrepancy map which predicts simulation model error for validation. 3. Creating virtual sensors which predict gas flow temperatures within engine components. The final predictive model is capable of predicting temperatures in real time. The analytics to be presented rely on several methodologies and techniques. Many of the methods rely on surrogate model based approaches which require efficiently constructing an accurate statistical model of the system. This involves sampling a model or physical system to collect training data for the surrogate model. Sampling is typically done using a Design of Experiment (DOE) or sub-selection from a large data set. Once constructed, the surrogate model is used in place of the true system to perform sampling-intensive analytics or to make real-time predictions such as for control applications.

Presenter Name: O'Flaherty, Kevin

Presenter Company: SmartUQ

Presentation Title: Using Statistical Calibration for Model Verification and Validation, Diagnosis of Model Inadequacy and Improving Simulation Accuracy (K. O'Flaherty, SmartUQ; Lvl: 3)

Type: Presentation

Keywords: Certification by Simulation, calibration, statistical calibration, uncertainty quantification, model validation

Session Title: Simulation Governance: Verification & Validation 2

Session #: 3-3

Room #: 24

Abstract:

The use of simulation models to displace physical tests has become essential in accelerating analysis and reducing the cost of research and design. However, as mathematician and statistician George E. P. Box said, “Essentially, all models are wrong, but some are useful.” Simulation results may be substantially different from reality, making accurate model calibration and validation critical to achieving desired outcomes. Using a method like statistical calibration can characterize model inadequacy by combining aspects of calibration and validation. By using a calibrated simulation model, designs can be certified and accepted with reduced physical testing. Statistical calibration can reduce design cycle time and costs by ensuring that simulations are as close to reality as possible and by quantifying how close that really is. It optimizes tuning of model parameters to improve simulation accuracy, and estimates any remaining discrepancy which is useful for model diagnosis and validation. Because model discrepancy is assumed to exist in this framework, it enables robust calibration even for inaccurate models. The presentation will introduce the concepts and advantages of statistical calibration and model validation. Using an air foil CFD model case study, this presentation will walk through the step-by-step process of performing statistical calibration and quantification of the uncertainty of the final calibrated model. The model will be a seven-parameter k-omega CFD turbulence model simulated in COMSOL Multiphysics. The model predicts the coefficients of lift and drag for an air foil defined using a 6049-series air foil parameterization from the National Advisory Committee for Aeronautics (NACA). The model will be calibrated using publicly available wind tunnel data from the University of Illinois Urbana-Champaign’s (UIUC) database. Multiple metrics will be shown which can be used for model validation, including a discrepancy map which characterizes inadequacies in the simulation. An analysis will be performed to compare results from a calibrated model and an uncalibrated model. The analysis will include optimization and sensitivity analysis. The results will illustrate the importance of calibrating a model before drawing design conclusions.

Presenter Name: ÖNGÜT, Alp Emre

Presenter Company: Siemens Industry Software NV

Presentation Title: A Simulation Methodology for the Design of Trailing-Edge Flap Deployment Mechanism (A. ÖNGÜT, Siemens Industry Software NV; Lvl: 2)

Type: Presentation

Keywords: multibody simulation, optimization, nonlinear structural analysis, Clean Sky 2, flap deployment mechanism

Session Title: Multibody Simulation 1

Session #: 3-2

Room #: 26C

Abstract:

A Simulation Methodology for the Design of Trailing-Edge Flap Deployment Mechanism A. E. ÖNGÜT, E. ALLEGAERT, Y. LEMMENS (Siemens PLM Software, Belgium) Abstract In the framework of the European research project Clean Sky 2 GRA-Airgreen2 [1], a simulation methodology for the design of trailing-edge flap deployment mechanism has been developed. The methodology is composed of software tools for linear and nonlinear flexible multibody simulation, structural analysis and parameter optimization. First, multibody simulations of the conceptual deployment mechanism for various load scenarios are performed. After the component loads are determined and reviewed by the user, a parametric optimization of component dimensions is performed. Finally the optimized parts are assembled into a multibody analysis with nonlinear structural components for the final verification of loads and ultimate structural limits. The data transfer between the different analysis tools have been streamlined such that design iterations can be performed in an efficient manner. The methodology is applicable to various mechanisms in many industries such as aerospace and automotive. Introduction The design of complicated engineering mechanisms poses a challenge to the engineers and generally requires many iterations until the final design is obtained. In order to automatize and streamline this procedure and address different design challenges, a design methodology has been developed that comprises various mechanical design and simulation software. As mechanisms encountered in engineering applications are composed of multiple interacting components with joints, forces, contacts and similar other constraints between them, multibody simulation is crucial to determine the loads acting on every component. With the help of Simcenter Motion, it is possible to create a flexible multibody model and simulate it for various load scenarios. After the multibody simulations are performed for different load scenarios, a python script is used to extract the information from the result files and write to a spreadsheet for each component, so that the user can review the critical load cases for every part and choose the most critical ones as necessary. After the critical load scenarios are determined, component sizing analyses were undertaken using the optimization software HEEDS together with Simcenter and NX Nastran linear structural solver in order to minimize the mass of every component while satisfying the structural safety factors. The sizing analyses were performed for the tracks, links and carriages of the deployment mechanism. As the final step, the optimized geometries are assembled back for the verification of design loads and ultimate structural limits. For this purpose the nonlinear multibody solver (NX Nastran SOL 402) in Simcenter is used. Since the nonlinear multibody solver combines the kinematic joints and constraints with the nonlinear structural model, it is possible to determine the component loads and plastic deformation of the structure at the same time for the critical loads scenarios and verify that the ultimate structural limits are not exceeded. Conclusions As part of the European research project Clean Sky 2 GRA-Airgreen2, a simulation methodology for the design of a trailing-edge flap deployment mechanism has been established. The methodology enables a semi-automatic design process that includes the identification of the component interface loads, sizing of the components within an optimization loop and non-linear validation analyses. The methodology can be used in combination with architecture-based synthesis [2] to efficiently analyze and compare many different design configurations. Furthermore, the described simulation methodology can be adapted and applied to various mechanisms in other industries. References [1] “Clean Sky 2 Green Regional Aircraft,” [Online]. Available: http://www.cleansky.eu/green-regional-aircraft-gra. [2] E. Allegaert, Y. Lemmens and G. La. Rocca, “Architecture-based design for multi-body simulation of complex systems,” in 2017 IEEE International Systems Engineering Symposium (ISSE), Vienna, 2017.

Presenter Name: Ortega, Alejandro

Presenter Company: Joyson Safety Systems

Presentation Title: Increasing Predictability in Simulations of Thermoplastic Airbag Module Components Using Plasticity and Failure Model Characterization Techniques (A. Ortega, Joyson Safety Systems; Lvl: 2)

Type: Presentation

Keywords: cae predictability, structural analysis, thermoplastics, airbag module, automotive safety, material characterization, plasticity, failure, strain rate

Session Title: Structural Analysis 1

Session #: 1-1

Room #: 26B

Abstract:

The objective of this work is to accurately predict deformation behavior and structural failure of airbag module components made of automotive thermoplastic resins such as glass-reinforced nylon or thermoplastic olefins (TPO) withstanding multiaxial dynamic loads originated from an airbag deployment event. Simulations of airbag deployment events have been previously and extensively studied considering an accurate representation of pressure and traction loads coming from airbag unfolding along with the explicit representation of surrounding thermoplastic components such as airbag covers and housings. However, material models for such polymeric structural components make use of nominal properties coming directly from single laboratory tensile tests or by making strong assumptions from specification sheets. Also, selection of their corresponding mathematical formulations attend to efficiency and practicality rather than accuracy and suitability for polymer-specific features of mechanical behavior. While this has provided a quick approach for structural analysis, these models miss the fact that airbag module structural components are commonly constructed from real-life application engineering thermoplastics that are gone through a complex history of mechanical transformations, and that these have a natural non-uniform distribution of essential properties. Thus, this ultimately remains a qualitative methodology. In order to have more realistic structural behavior and failure predictions for CAE to support airbag module structure designs in a precise way, material models require to consider a realistic state of thermoplastics by consideration of more variables coming from manufacturing and testing processes, including effects such as: natural anisotropy, redistribution of local material property orientations due to an injection molding process and strain rate effects, among others. These elements will impact plasticity behavior and overall failure strength thresholds, prominently deviating calculations from an idealized structural simulation. A methodology for improving characterization of involved thermoplastics' material behavior along with the structural impacts of the injection molding process has been developed in order to conform LS-DYNA material and failure models capable of taking all the aforementioned realistic mechanical effects into account when performing airbag deployment or any other kind of mechanical load simulations involving viscoplastic structural components. The characterization process starts with the construction and correlation of material plasticity models by performing basic tensile tests in different orientations of samples at different strain rates. An anisotropic material model is implemented and its plasticity parameters are validated. Next, a damage and failure model are added by correlating the final elongation and the specific rupture pattern observed in the samples using the data from these tensile tests themselves or other custom testing programs designed for this purpose, going through an iterative CAE simulation process to reach full fundamental plasticity and failure correlation. Simulations of the injection molding take place by making use of Moldflow. Its results are used to obtain a distribution of local material properties orientation within the thermoplastic components. This data is used by a further simulation tool to accurately map this specific property distribution into a structural simulation, conforming a baseline model. This way, the effects anisotropy induced by the molding process are considered in the structural analysis for the main intended application load simulations. Some sampling models have been validated by a set of experiments. Simulations with and without going through the characterization methodology have been compared to experimental data from basic tensile, airbag deployment and custom-made test setups. Results suggest that having this characterization process improves the accuracy of specific failure event predictions.

Presenter Name: Overton, Jerry

Presenter Company: DXC Technology

Presentation Title: AI in Manufacturing: How to Run Longer, Run Better and Keep Relevant (J. Overton, DXC Technology; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 2

Room #: Grand Ballroom B

Abstract:

Imagine if you could anticipate equipment service needs in advance, accurately, and spend time only servicing the equipment that needs it when it needs it. Imagine, too, if you could make smarter production design decisions that optimize the overall manufacturing process. You can, with data you already have, by leveraging it using artificial intelligence (AI).

Presenter Name: Ozcelik, Yunus

Presenter Company: Borusan Teknoloji Gelistirme ve Arge AS.

Presentation Title: Parametric FEM for Dynamic Response Modeling of Plates Partially Covered with Constrained Layer Damping Treatment (Y. Ozcelik, Borusan Teknoloji Gelistirme ve Arge AS.; Lvl: 3)

Type: Presentation

Keywords: plates, damping, contrained layer, viscoleastic material

Session Title: Structural Analysis 1

Session #: 1-1

Room #: 26B

Abstract:

Plates are initially flat structural components bounded by two parallel faces. Because of several structural advantages, plates are used in bridges, airplanes, automobile, missiles, ships and machine parts. Surface damping treatment is used to solve resonant noise and vibration problems associated with plates. One of them is constrained layer damping treatment, where viscoelastic layer is sandwiched between base plate and a stiff constraining layer. Constrained damping treatment is widely used in automotive components such as dash panel, oil pan, rear wheel wells to reduce unwanted vibration and noise levels. Moreover, using constrained layer damping on the automobile components reduce complexity, weight and cost compared the traditional NVH treated components. Therefore, modeling of components covered with constrained layer damping is vital to optimize thicknesses of lower, middle and upper layers. In this study, dynamic response of plates partially covered with constrained layer damping treatment is studied using ANSYS Parametric Design Language (APDL). Geometry of base plates, viscoelastic and constraining layers, mesh density, material properties, boundary conditions are modeled parametrically using ANSYS APDL. Since mechanical properties of viscoelastic materials are affected by operating temperature, shift factor is calculated using Arrhenius Model to take operating temperature into account. Complex modulus and loss factor for each interested frequency is computed using Ross, Kerwin and Ungar (RKU) equations. In the light of above information, the program calculates desired natural frequencies and mode shapes. Moreover, frequency response function of plates are calculated for interested frequency range. Besides, the efficiency of constrained layer damping treatment is examined in detail by comparing dynamic response of both damped and undamped plates. In the second part of this study, parametric finite element model is verified using analytical formulations, where dynamic response of beam covered with constrained layer damping treatment is computed using continuous beam formulations. Both analytical and finite element methods are compared for a simple case. After verification of parametric finite element model, several case studies are conducted to determine optimum design for different boundary conditions by changing thickness and location of both viscoelastic layer and constraining layer. As a conclusion, dynamic analysis of plates covered with constrained layer damping treatment using parametric finite element method is time saving compared to traditional analysis techniques since different materials, boundary conditions, thickness of both viscoelastic and constraining layers are simulated by changing only relevant parameters in the script.

Presenter Name: Ozturk, Burak

Presenter Company: VIAS

Presentation Title: Design Optimization of a Piping System for Fatigue and Strength Using Coupled FEA and CFD Simulation Techniques (B. Ozturk, VIAS; Lvl:)

Type: Presentation

Keywords: DESIGN OPTIMIZATION, FATIGUE, FEA, ISIGHT, FE-SAFE, ABAQUS, CFD, STAR CCM+, FSI, FLUID INDUCED VIBRATION

Session Title: Multiphysics 2

Session #: 3-1

Room #: 21

Abstract:

Multi-phase flow introduces many challenges in understanding and analyzing its unpredicted and unsteady behavior, and it sometimes induces significant amplitude vibrations due to oscillating forces in particular on bends and elbows of piping systems. It is understood that the likelihood of failure increases when the fluid frequency oscillates at the natural frequencies of the structure since there is an amplification of the response. Understanding this flow induced vibration phenomenon is important to identify the variables predicting its physical behavior, and thus developing a methodology that can help to predict the high amplitude vibrations due to pressure fluctuations of the multi-phase flow. It is then needed a technique or method that allows duplicating this fluid structure interaction scenario and finds the parameters affecting the stability and integrity of the structure. The present fluid structure interaction analysis will benefit to recognize flow induced vibrations issues in similar onshore and offshore piping systems. The purpose of this paper is to determine the effect of multiphase flow (oil-gas-water) on the structure of the piping system by performing a direct coupling simulation between ABAQUS and Star CCM+ and to optimize the piping system design by taking into account the inherent uncertainties in the design parameters and by accurately capturing the interaction between the effects of varying the parameters. A strength check and fatigue analysis will be carried out to indicate whether it is required to design a mechanism or process that modifies the most influential flow parameters and conditions in case flow induced vibrations occur in a piping system. In addition a commercial process automation and design optimization tool Isight will be used to perform the reliability based design. First, using Isight, a design of experiment (DOE) based sampling (such a Latin Hypercube technique) will be performed to accurately sample the design points to capture the effects and interaction of input parameters on the stress outputs. Then, using suitable mapping technique (such as Hyperkriging) a response surface function will be obtained. The response function will be checked for accuracy before further stochastic analysis. Using the analytical mapping function, reliability based design optimization (RBDO) will be performed considering random input parameters. The optimized design will meet the objective (response stresses less than the code allowables) in a stochastic sense with target low probability of failure.

Presenter Name: Pandheeradi, Murali

Presenter Company: Dassault Systemes SIMULIA Corp

Presentation Title: Efficient Modeling and Simulation of Welding Processes (M. Pandheeradi, Dassault Systemes SIMULIA Corp; Lvl: 2)

Type: Presentation

Keywords: welding, AWI, distortion, residual stresses, Goldak model, progressive element activation

Session Title: Simulation of Manufacturing Methodologies & Processes 2

Session #: 3-2

Room #: 25B

Abstract:

The presentation will highlight how new technologies, including the strain-free element activation that follows the physical, space- and time-dependent material deposition (as occurs in additive manufacturing), known as "element progressive activation" also benefits simulation of traditional welding processes, making it much more efficient. “Element progressive activation” (EPA) improves solver preprocessing and analysis performance significantly, and is already used with the Abaqus solver on the 3DExperience platform for additive manufacturing simulations. With EPA, strain-free element activation is no longer an analysis step-dependent feature. It is therefore superior to “model change” (in Abaqus solver) or equivalent approach traditionally used in welding simulations. EPA and the corresponding new model input structures also make for an efficient implementation of a continuous moving torch associated with many welding processes to capture the flux-based energy input, whether it is through well-known Goldak double ellipsoid model or other moving heat source models commonly used in welding simulations. With some automation of pre-processing, it is relatively straight forward to setup a complex 3-D welding analysis model that takes advantage of these new technologies, making realistic simulation of welding processes possible. The presentation will also include a discussion of methods that are more approximate than the moving torch methods, but are more practical and efficient, especially for large models, while still providing acceptable results depending on the simulation objective (e.g. prediction of distortion vs. accurate residual stresses). The 3D “chunking” option, where the bead deposition is approximated as a series of discrete "chunks" (the number of chunks typically controlling the solution accuracy) while still using flux-based energy input to match the torch power, will be illustrated as one such efficient alternative. It is well known in the welding community, as evidenced from the large number of articles in the published literature, that advanced simulation capabilities like those that will be discussed in the presentation provide an efficient and cost-effective alternative to expensive experimental trial-and-error approach to understanding and optimizing the welding processes. The presentation will conclude with sample simulation results from several example problems in welding as well as validation of models by comparing with experimental results using select, published benchmark problems. A comparative study of the performance of the different modeling options (continuous vs. "chunking") for representative welding problems will also be discussed.

Presenter Name: Panthaki, Malcolm

Presenter Company: Comet Solutions, Inc.

Presentation Title: The Challenges and ROI of the Democratization of Simulation – Why Progress is Slow (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)

Type: Presentation

Keywords: Simulation Driven Design, SPDM, Design/Process Automation for Optimization, Simulation Automation, CAD/CAE Integration, Non-Experts Accessing Simulation, Democratization of Simulation, Simulation Governance

Session Title: Democratization 1

Session #: 1-1

Room #: 23

Abstract:

The democratization of simulation software has the potential to increase the number of simulation users by one or more orders of magnitude. Similar dramatic expansions of use of complex technologies have been witnessed in many other technology-driven industries such as automobiles, airplanes, personal computers and high performance computing, navigation systems, music devices, and communications devices such as phones. In each of these cases, the expansion occurs when the nascent, complex, hard-to-use technology is packaged into a form that is simple-to-use, robust, affordable and accurate. But this turning point is never simple to accomplish and hard to predict. However, when it does happen, it has always resulted in an explosion of investment and innovation that further drives the power and use of the underlying foundational technologies. Simulation software is one such complex technology that the authors believe is close to the inflection point. However, while many end-user organizations have been successfully implementing the democratization process, progress has been slow. What are the challenges facing the democratization of simulation software? Why has it taken a while to get to this point, which is still not yet the turning point that is characterized by an explosion of usage? What are the key considerations for achieving safe and robust simulation democratization within a globally-dispersed and culturally-diverse organization? The authors of this paper suggest answers to these questions based on many man-years of experience implementing and deploying the software that facilitates democratization, as well as actually implementing the strategies and tools needed to democratize simulation within their global teams. Is the use of templates essential to the democratization of simulation? If so, how can these templates be made robust across an entire family of products that share a common functional architecture? The authors will provide an example of a graphical workspace that has facilitated the rapid creation of the simulation automation templates that are at the core of the SimApps used to drive democratization within a number of end-user organizations. What are the essential ingredients of a successful implementation? What are the various pitfalls one must be aware of and what are some of the strategies that have been employed to overcome these? Can cultural barriers and the status quo derail an effort to implement democratization and how can one overcome these barriers? The authors will describe their experiences at GKN Driveline and NASA Langley - the challenges they faced and the successes of their approaches.

Presenter Name: Panthaki, Malcolm

Presenter Company: Comet Solutions, Inc.

Presentation Title: Democratizing Engineering Models – Part 2: Evaluating 3-D CAD Designs (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)

Type: Workshop

Keywords: democratization

Session Title: Democratizing Engineering Models - Part 2

Session #: 2-3

Room #: 23

Abstract:

In Part 1 of the SimApps Workshop Series, the workshop participants were introduced to the use of a low-code web app development environment (EASA) to rapidly create web-deployed SimApps for the democratization of low-fidelity engineering models that are implemented in generic mathematical modeling tools such as Excel and MATLAB. In Part 2 of the SimApps Workshop Series, we will introduce the workshop participants to techniques and platforms that can be used to rapidly templatize complex 3-D simulation processes starting with 3-D CAD representations of a design. A useful and robust simulation automation template is one that automatically performs 3-D simulation, going from a CAD model representation of the design to the simulation report "in a single click". To increase its usage, such a template must be easily and safely usable by those that are not experts in the underlying CAD and CAE tools that are used to produce the required results. Furthermore, it is a requirement that the template be developed rapidly using a low-code, graphical programming environment that significantly speeds up the process of creating these complex templates, reducing or even eliminating the need to use coding or scripting that is difficult to maintain and enhance. The Comet Workspace is a low-code graphical programming environment for the rapid development of simulation automation templates that use 3-D CAD representations (PTC Creo, NX, SolidWorks, SpaceClaim, Inventor, and Fusion) of a product design as input. Comet templates can utilize various computation engines to perform the necessary calculations – examples of tools that Comet has adaptors for are Excel, MATLAB, Mathematica, ANSA (for meshing), ANSYS, Abaqus, Nastran, LS-Dyna, MSC Adams, ThermalDesktop, and CodeV and Zemax (for optical simulations). Workshop participants will: • Learn how these 3-D simulation templates are created. • Learn what makes templates robust across an entire product family – how are the rules implemented, how are templates verified and validated, etc. • Learn how these 3-D simulation templates can be driven by EASA-based, simple-to-use web-deployed SimApps. • See and experience various examples of SimApps and the underlying templates that use one or more CAD and CAE tools to perform simulations and generate reports. Participants will access a library of SimApps to get hands-on experience with them, giving them a clear understanding of how simple it can be to access complex simulations using multiple underlying general-purpose CAD and CAE applications.

Presenter Name: Panthaki, Malcolm

Presenter Company: Comet Solutions, Inc.

Presentation Title: RevolutionInSimulation.org – a new, public Web Community for the Democratization of Simulation (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)

Type: Presentation

Keywords: democratization, revolution, simulation, RiS

Session Title: Democratization 5

Session #: 3-1

Room #: 23

Abstract:

RevolutionInSimulation.org (RiS) is a new industry-wide, collaborative initiative that aims to provide the resources necessary for implementing the Democratization of Simulation at organizations that can benefit from the expanded use of simulation tools. This public web portal serves as a resource center for information related to the revolution that is underway in the simulation world. In particular, there are many changes afoot that promise to democratize simulation, bringing the power of simulation to everyone, not just the experts. Here, you'll get access to the latest useful news, articles, presentations, videos, webinars, success stories and other related materials. You will also be able to access various industry experts, organizations, and service & software solutions providers who can help you and your organization join the revolution and, thereby, significantly improve the ROI on your simulation investments. We're entering a new era in simulation – see for yourself what this revolution is all about and take the necessary steps to implement this new approach in your organization! This presentation will introduce you to this nascent initiative – why should you care, how can you join, what resources are available, how to access numerous success stories, who are the Moderators of the various relevant topic areas, what steps can you take to initiate a test program, and more! There will be time for a Q&A session to address your questions.

Presenter Name: Panthaki, Malcolm

Presenter Company: Comet Solutions, Inc.

Presentation Title: Democratization Roundtable Discussion/Q&A (M. Panthaki, Comet Solutions, Inc.; Lvl: 2)

Type:

Keywords: democratization, roundtable

Session Title: Democratization: Roundtable

Session #: 3-2

Room #: 23

Abstract:

A panel consisting of all the presenters in this track will engage in a roundtable discussion and free-form Q&A session with the audience. The primary conclusions from all the presentations will be briefly summarized and the floor will then be opened for questions. The audience should expect a lively discussion with many, often differing points-of-view on this nascent and exciting area of simulation. Democratization promises to significantly expand the use of this powerful technology throughout the product development process, putting it safely and robustly in the hands of people who are not experts in the underlying simulation tools. Should you care about the democratization of simulation? What benefits are you missing out on? How can you significantly increase the ROI on your simulation investments? What are the challenges still to be addressed?

Presenter Name: Papadopoulos, Theodoros

Presenter Company: Siemens AG

Presentation Title: Towards CFD Democratization in Pre-development (T. Papadopoulos, Siemens AG; Lvl: 2)

Type: Presentation

Keywords: cfd democratization, electric motor, heating, CFD

Session Title: Democratization 3

Session #: 2-1

Room #: 23

Abstract:

Nowadays CFD simulations (both simple and advanced) are carried out solely by experts through the whole design process and development phase. However, the available number of the CFD experts is limited especiallyin the pre-development phase. During this phase the CFD experts have to investigate several scenarios which differ usually in only some parameters for example in velocity or temperature. Such processes are very time demanding and ending in a non-efficient R&D process. What if the CFD tasks could be “extended” to other members of the R&D process with minor effort? Thus, the effort for a preliminary investigation could be allocated among several team members and boost the design phase. Such involvement of experts from other fields like CAD designers can be realized by applying predefined workflows. These workflows have to be initially developed by a CFD expert and their use has to be intuitive. This paper demonstrates an example of a workflow to realize this concept. As case study electric motors are selected and more specific the design of the motor’s housing. Electric motors generate heat during their operation as a result of both electrical and mechanical losses. This emitted heat is essential to be removed in order to ensure the proper operation of the motor. The dissipation of the heat is achieved in most cases through conductive cooling (housing of the motor). To increase the outer heat exchange surface between the housing and the cooling medium usually fins are placed on the housing. Apart from their power electric motors may differ in the housing geometry (i.e. dimension, number and size of the fins etc). Thus, each motor should be designed and computed separately to investigate its cooling process. However, the "physics" of the problem is the same for these cases. Thus, the preliminary evaluation of the motor housing ends to become a highly time consuming numerical method. Aim of the current work is to demonstrate a workflow from a 3D parametric CAD file till the visualization of the CFD results.

Presenter Name: Papadopoulos, Theodoros

Presenter Company: Siemens AG

Presentation Title: Accurate Interactive 3D Engineering Simulations Accelerated by GPUs (T. Papadopoulos, Siemens AG; Lvl: 2)

Type: Presentation

Keywords: FEM, Interactive Simulation, GPU, Multi-grid Solver, Topology Optimization, Simulation-based Service

Session Title: High-Performance Computing/Supporting Infrastructure

Session #: 2-3

Room #: 25C

Abstract:

The vision of a digital twin as a companion of the real product is an emerging concept to manage complexity of today's products as well as to enable new digital services. Interactive simulations, i.e. close-to-real-time or faster-than-real time simulations are a key technology to unleash the potential of digital twins. By means of these interactive simulations, functional behavior can be predicted in detail e.g. during operation and make it as natural to interact with the virtual twin as with the real system. In the last years, corresponding computational speeds have been reached only by lumped system models such as used in hardware-in-the-loop simulation. Recently, interactive 3d simulations have been introduced in computer graphics, where these are used for visualization purposes mainly in the movie industry. Inspired by these concepts, we present a novel approach to 3d interactive simulations combining simple structured hexahedral discretizations with efficient geometric multi-grid solvers implemented on GPUs. Coupling boundary conditions in a weak sense, i.e. by means of Nitsche's method, interactive finite element simulations sufficiently accurate for engineering applications are possible. The developed prototype can solve FEM computations with more than 1 000 000 elements within a few seconds. As we demonstrate in this paper, these interactive simulations enable novel simulation-based engineering applications outside the classical field of computer aided engineering such as design assistance for ideation or novel service concepts for mechanical parts. Combining interactive simulations with topology optimization enables to run a complete topology optimization in less than 2 minutes. This allows designers to evaluate many concepts during the design stage and to come-up with novel highly efficient designs. Not only during design but also during service, interactive computations bring enable novel applications. Scanning damaged mechanical parts and corresponding instantaneous structural evaluation allow a highly accurate assessment of damages. By means of simulation fact-based decisions whether to exchange or not to exchange a part are possible.

Presenter Name: Paul, Ryan

Presenter Company: GrafTech International Holdings Inc.

Presentation Title: Simulation of Effect of Porosity on Properties of Synthetic Graphite (R. Paul, GrafTech International Holdings Inc.; Lvl: 2)

Type: Presentation

Keywords: Finite element analysis, modeling, porosity, graphite, X-ray computed tomography, COMSOL, Simpleware

Session Title: Advanced Materials Characterization

Session #: 1-2

Room #: 25A

Abstract:

Synthetic graphite materials are a class of engineering materials used in a multitude of high temperature applications, for example steel melting, nuclear reactors, and rocket nozzles. Specifically, graphite has excellent thermal shock resistance and high temperature stability in inert atmospheres. Graphite always contains porosity due to the raw materials and processing steps. The raw materials and processing can be tailored so as to create graphite with a range of properties, for example strength, density, thermal conductivity, and electrical resistivity, as well as the isotropy of each property. For example, isotropy is desired for nuclear grade graphite, but anisotropy is desired for graphite electrodes for electric arc furnace steel melting. However, most finite element and multiphysics modeling assume a homogenous structure in a material, due to the numerical complexity of incorporating porosity and other heterogeneity into the model. Therefore, the material in the finite element model is a simplification of the real material, and it has not been well understood how the homogenization of the material affects the interpretation of the results. Of course, this also affects the model inputs. This talk will highlight several three-dimensional finite element models which were built to directly incorporate the porosity, based on X-ray tomography scans of graphite samples. Samples were taken from a grade of synthetic graphite used as graphite electrodes in electric arc furnace steel melting. The talk will discuss the workflow of obtaining the high-resolution scans and using the Simpleware Software Platform (Synopsys Inc, Mountain View, CA) to segment the scans into pores and solid and generate a volumetric Finite Element (FE) meshes. COMSOL Multiphysics (COMSOL Inc, Burlington MA) was then used to apply the material properties, and boundary conditions, before solving the models. Differences between the homogenous model and the heterogeneous model with pores will be highlighted, including a discussion on the model inputs, tradeoffs between simplicity and realism in the structure and the effect on computational resources and interpretation of results.

Presenter Name: Perifanis, Antonis

Presenter Company: BETA CAE Systems SA

Presentation Title: Advanced Results Compression Combined with a Sophisticated and Out-of-the-Box Simulation Data Management System: A Case Implemented at Honda (A. Perifanis, BETA CAE Systems SA; Lvl: 2)

Type: Presentation

Keywords: Results compression, Simulation data management

Session Title: Simulation Governance: Data Management 1

Session #: 2-1

Room #: 24

Abstract:

The automation in post processing has shifted the weight away from interactively examining the simulation results. In the simplest of the cases, the original solver files are replaced by post processing software native databases with targeted results, whereas in the most complicated cases a series of report data are stored in data management systems. This paper presents a solution in the field of results compression and simulation data management. The compression capabilities of the post processor META's native database, especially designed for results comming from simulation, exceeds by far the conventional compression solutions. This leads to significant benefits regarding the storage size and loading, or the downloading time from the server. The tool offers full control of the data stored and advanced parameterization per model/component/part and per result. The model simplification techniques produce 3d databases with a satisfactory representation of the results field in the size reduced to the hundredth compared to the original ones. In a further step, the functionality can be effectively combined with the results data management system of BETA CAE systems' software suite. In this presentation, Honda Japan successfully deploys this data management system for NVH results. The compressed databases with 3d and 2d results can be automatically generated after each run is finished keeping the version and the other meta-data related to the simulation models. The results from such databases can then be used both for brief overview presentations and for interactive in-depth analysis using available predefined layouts. In a future step, the employment of the simplified model 3d database can yield noticeable benefits at a negligible additional cost. The simplified database can be loaded in minimum times for an initial results check with the option to interchange between the simplified and the original representation on component/part level on the fly and only where needed.

Presenter Name: Popielas, Frank

Presenter Company: SMS_Thinktank

Presentation Title: Systems Engineering – Challenges for Management (F. Popielas, SMS_Thinktank; Lvl: 2)

Type: Presentation

Keywords: Systems Engineering, System Modeling and Simulation, CAE, sustainable Innovation, Maturity, Simulation & Analysis, Cultural change, digital twin, internet of things,

Session Title: Systems Simulation 1

Session #: 2-2

Room #: 26C

Abstract:

To remain competitive in our modern fast-paced engineering environment companies are challenged, not only to leverage the latest technology to their processes and engineering tools in product and process development, but they are also being tasked to re-invent themselves as a business. Companies can no longer afford to develop products in a "vacuum" but must now interact across well defined "silos" of subject matter experts during product development, market introduction as well as in-service to retirement. In our modern connected world, to properly utilize virtual engineering, companies must be able to adopt methods and processes that enable technologies such as the Internet-of-Things (IoT), Digital Twin, etc. Systems Engineering thinking and the enablement and deployment of the latest best practices and solutions in this space are crucial for the successful development of complex systems that have become part of most products in today's world. Within companies, it has become apparent that tools alone will not save the day. Tools alone can no longer be the guiding factor for developing sound business processes. Companies need to re-think the way they work and organize themselves. They need to start thinking in terms and order of: Organization / Culture - Processes - Tools. This requires, especially for management, a more active engagement model while at the same time provide an environment for creativity and flexibility for their workers. Traditional methods to run a business are no longer sustainable for the long term. Some critical adjustments must be made to allow for innovation. One of the major challenges traditional engineering companies face in this context is, how to merge simulation & analysis with the world of systems engineering into system modeling and simulation (SMS) and how to realize the benefit from creating such system modeling and simulation driven engineering environment. In this presentation we will discuss the technical challenges management is currently facing and how they can be addressed in this ever-increasing complex engineering environment.

Presenter Name: Prescott, Patrick

Presenter Company: Owens Corning Science & Technology

Presentation Title: An Overview of Mathematical Modeling and Numerical Simulation in Glass Fiber Manufacturing (P. Prescott, Owens Corning Science & Technology; Lvl: 2)

Type: Presentation

Keywords: Glass Melting, Fiber Forming, Manufacturing Process, Productivity

Session Title: Simulation of Manufacturing Methodologies & Processes 1

Session #: 3-1

Room #: 25B

Abstract:

An Overview of Mathematical Modeling and Numerical Simulation in Glass Fiber Manufacturing Patrick Prescott, Bruno Purnode, Jong, Han, and Josh Rowe Owens Corning Science & Technology Center Granville, Ohio Abstract – The presentation begins with an introductory overview of Owens Corning, followed by a focus on product forms offered by the Composites Solutions Business (CSB) of Owens Corning. Manufacturing processes for CSB products are described, with special attention placed on physical phenomena which affect productivity and the challenges associated with measuring and/or estimating their effects. Mathematical modeling and numerical simulation are used extensively in various aspects of applying technical expertise to glass fiber manufacturing, including troubleshooting, adjusting operational settings for improved performance and/or changing production levels, materials substitution, and for screening concepts for improved process design. The advantages and challenges of using numerical simulation are discussed. The modeling choices depend on the technical and/or business circumstances such as allotted time or level of detail required to render a decision. Some of these modeling choices are presented with several examples showing how simulation results help make technical decisions in glass fiber manufacturing operations. Some of these examples are multi-physics and/or multi-scale in nature, while others are less complicated but still important. Some simulations are primarily thermal and fluid flow related, and others are structural in nature. Processes included in the presentation involve glass melting, transport and thermal conditioning of glass between a melting furnace and fiber forming positions, waste heat recovery, and other aspects of the manufacturing operation. Challenges with measuring operational conditions or material properties are addressed, as they represent significant uncertainties which would ideally be eliminated. We will also cover how the simulation results and data are managed, stored, and shared. The presentation will demonstrate how modern computational resources can be leveraged to improve overall productivity and/or business agility.

Presenter Name: Rajagopalan, Baskar

Presenter Company: NVIDIA

Presentation Title: CAE Goes Mainstream with GPU-Accelerated Computing (B. Rajagopalan, NVIDIA; Lvl: 1)

Type: Presentation

Keywords: CAE, CFD, FEA, design simulation, GPU, GPGPU, HPC

Session Title: High-Performance Computing/Supporting Infrastructure

Session #: 2-3

Room #: 25C

Abstract:

GPU-accelerated computing is the use of a graphics processing unit (GPU) together with a CPU to accelerate deep learning, analytics, and engineering applications. Pioneered in 2007 by NVIDIA, GPU accelerators now power energy-efficient data centers in government labs, universities, enterprises, and small-and-medium businesses around the world. GPU-accelerated computing, sometimes referred to as general-purpose GPU computing (GPGPU), offloads compute-intensive portions of the application to the GPU, while the remainder of the code still runs on the CPU. From a user's perspective, applications simply run much faster. GPUs are increasingly being used for CAE visualization and computing thanks to 2-10x gains in wall-clock time they provide over CPU only systems. All major computing hardware manufacturers including workstations and server as well as cloud providers have adopted NVIDIA GPUs as part of their systems and datacenters as over 500 applications are GPU accelerated today. Specifically, in the CAE domain, over 50 FEA, CFD, and CEM applications run on NVIDIA GPUs. NVIDIA provides different ways to port applications to the GPU. These include SDKs, libraries, compiler directives and CUDA®, a parallel computing platform and programming model developed by NVIDIA for general computing on GPUs. New computational methods that demand high computing power are now popular as they are being developed to run on GPUs. These include the Lattice-Boltzmann Method(LBM), Smoothed-Particle Hydrodynamics(SPH) for CFD, Discrete Element Modeling(DEM) for particle simulation, Ray Tracing for radiation, etc. Design methods/tools such as generative design, topology optimization, interactive design-simulation and simulation of downstream manufacturing processes such as additive manufacturing and 3D printing also benefit from GPUs dramatically improving produtivity. This session will review the acceleration techniques for some of the major FEA, CFD, and CEM applications along with representative benchmarks using the latest NVIDIA GPU hardware. Attendees will learn ways to optimize hardware and software resources for the maximum return on investment.

Presenter Name: Ramish, Ramish

Presenter Company: NED University of Engineering and Technology

Presentation Title: Design and Development of an Optimal Fault Tolerant 3 Degree of Freedom Robotic Manipulator (R. Ramish, NED University of Engineering and Technology; Lvl:)

Type: Presentation

Keywords: Redundant, fault tolerant, Jacobian, Gram Matrix, kinematics, trajectory planning, Lagrange-Euler, Denavit-Hartenberg

Session Title: Multibody Simulation 2

Session #: 3-3

Room #: 26C

Abstract:

Kinematic redundancy within the manipulators presents extended dexterity and manipulability to the manipulators. Redundant serial robotic manipulators are very popular in industries due to its competencies to keep away from singularities during normal operation and fault tolerance because of failure of one or more joints. Such fault tolerant manipulators are extraordinarily beneficial in applications where human interference for repair and overhaul is both impossible or tough; like in case of robotic arms for space programs, nuclear applications and so on. The design of this sort of fault tolerant serial 3 DoF manipulator is presented in this paper. This work was the extension of the author's previous work of designing the simple 3R serial manipulator. This work is the realization of the previous design with optimizing the link lengths for incorporating the feature of fault tolerance. Various measures have been followed by the researchers to quantify the fault tolerance of such redundant manipulators. The fault tolerance in this work has been described in terms of the worst-case measure of relative manipulability that is, in fact, a local measure of optimization that works properly for certain configuration of the manipulators. An optimum fault tolerant Jacobian matrix has been determined first based on prescribed null space properties after which the link parameters have been described to meet the given Jacobian matrix. A solid model of the manipulator was then developed to realize the mathematically rigorous design. Further work was executed on determining the dynamic properties of the fault tolerant design and simulations of the movement for various trajectories have been carried out to evaluate the joint torques. The mathematical model of the system was derived via the Euler-Lagrange approach after which the same has been tested using the RoboAnalyzer© software. The results have been quite in agreement. From the CAD model and dynamic simulation data, the manipulator was fabricated in the workshop and Advanced Machining lab of NED University of Engineering and Technology.

Presenter Name: Ramkumar, Rohit

Presenter Company: Dana Holding Corporation

Presentation Title: Simulation-Driven Engineering and Its Role in the Product Development Process (R. Ramkumar, Dana Holding Corporation; Lvl:)

Type: Presentation

Keywords: SPDM, Data Management, Optimization, Abaqus

Session Title: Simulation Governance: Data Management 3

Session #: 2-3

Room #: 24

Abstract:

Over the past several years, complexity in product development has increased significantly. A greater number of design alternatives need to be evaluated despite time and resource constraints. To aid with the complexity of various engineering processes, engineering simulation and analysis has become an integral part of the engineering approach to product design and development. Up-front design analysis and optimization have proven to be integral in being faster to market and reducing costs. In addition, engineering simulation and analysis has become a global process. A wide range of users with varying levels of expertise need access to sophisticated simulation techniques and a unified approach to engineering strategy. In order to capture and deploy an organization's best practices, loosely defined ad-hoc processes must be converted into standardized processes based on both internal design guidelines and external customer-driven requirements. Methods standardization is essential to produce consistency in results. To aid in methods standardization and increase confidence in simulation results, validation and verification of the standardized process flow is necessary by means of physical testing and correlation. After establishing and validating standard processes, they are converted to guided practices, and ultimately to fully automated processes. SPDM (Simulation Process Data Management) provides the framework for process automation and is the engineering tool used for process capture and management. In this paper, standard and automated processes are presented to demonstrate how simulation has been integrated into the overall product development process. Examples of how virtual and physical test data are captured in a common platform are discussed in the context of validation and verification of standard processes and creating standardized input databases. Various analysis types and optimization examples are shown to illustrate different maturity levels of process automation and how a simulation-based design approach is becoming accessible across engineering disciplines at Dana Incorporated, thereby enabling simulation-driven design directions.

Presenter Name: Robinson, Kyle

Presenter Company: Southwest Research Institute

Presentation Title: Submodeling of Thick-Walled Structures with Plasticity (K. Robinson, Southwest Research Institute; Lvl: 2)

Type: Presentation

Keywords: FEA, submodeling, mesh, structural analysis, nonlinear, multiscale

Session Title: Multiscale

Session #: 1-1

Room #: 21

Abstract:

Fatigue analyses are an example of engineering calculations that rely on accurate peak stress results from structural simulations. A refined finite element mesh is necessary to capture these peak values but can be challenging for models that have unfavorable aspect ratios of the features of interest relative to the global model size. Submodeling has been a technique used in finite element analyses for decades, but misconceptions about proper use limit the application of this powerful capability, and these will be the focus of the talk. The presentation will discuss (a) submodeling using 2D axisymmetric-to-3D solid submodels, (b) submodeling using buffer zones to capture features such as small fillets, and (c) submodeling when plasticity is present. Plasticity in submodeling is perhaps the most controversial technique of the ones listed. An example problem will show the nuances of obtaining an accurate solution for these types of problems. Comparisons of the sub-modeled FEMs will be compared to a traditional, detailed, global FEM approach. An example of a mounting hole in a rib stiffener of a pressure vessel that includes material yielding will be used to illustrate all three of the aforementioned submodeling techniques. The example problem will show that the submodels make a finer mesh more feasible in critical areas while providing a numerical solution that is many times faster. Examples of implementation of submodeling on more complex ASME pressure vessel analyses will also be shown. Computational speedups become more dramatic on larger models. Naturally, there are tradeoffs, and the submodeling approach can take more time to document the results of analysis due to the increase in model numbers and the dependence on submodels to global models, for example. As simulation capabilities becomes more powerful, the science and art of simplifying models into manageable "chunks" gets lost. Submodeling brings the skill of the engineer/analyst/scientist back into the equation and can make the use of powerful CAE more efficient.

Presenter Name: Robinson, Chris

Presenter Company: ANSYS

Presentation Title: Additive Manufacturing Process Simulation Total Workflow (C. Robinson, ANSYS; Lvl: 1)

Type: Workshop

Keywords: Additive Manufacturing, Process Simulation, Workflow, ANSYS, Distortion, Residual Stress, Defects, Demonstration

Session Title: Additive Manufacturing Process Simulation Total Workflow

Session #: 2-2

Room #: 22

Abstract:

Contrary to what has been said for many years, Additive Manufacturing (AM) can be predictable! However, it requires appropriate physics and algorithms integrated in a simulation environment that considers the detailed specifics unique to AM. ANSYS has integrated internally developed solutions for the total additive manufacturing workflow with 3DSIM developed tools that can do what no other tool in the world can do. This workshop will provide attendees with an interactive opportunity to see the tools that are available to support AM users and Analysts from development to design to build preparation to fabrication with a particular focus on the benefits of process simulation. Today's AM development method of empirical trial and error requires a user to make an initial design and try to build the part in a given orientation with a given support structure and then iteratively make subsequent builds to get the support structure correct. After such iterations the part can be completed and evaluated for distortion or residual stress. If it is found that distortions are excessive or residual stress is causing problems with the part, different orientations may be built and evaluated. Each new orientation requires a different support structure, which can lead to more iterations of support structure development. If this proves to be insufficient to correct the problems then the part must be driven back to the design stage, modified and then the process must be followed again until the part can be fabricated successfully. This can take up to 15 iterations for many components. Through utilizing process simulation a designer or analyst can have access to the effects of distortion, residual stress, and part orientation, in addition to evaluating required support structure and manufacturing limitations such as blade crashes during the design phase of development. If desired the designer and analyst and can also have access to the effects of varying process parameters. For further evaluation, meltpool dimensions, thermal history, and microstructure can all be evaluated without ever utilizing any physical material or time on an actual machine. Total process simulation gives users a much more wholistic view of the problem all at once instead of requiring a large number of linear iterations to evaluate the problems. This will be an interactive workshop where attendees and workshop leader will work through the process of designing a part with the assistance of available workflow tools, including performance analysis, design optimization, AM print process simulation, and build setup. Attendees will have the opportunity to see how this workflow happens through the use of case studies as well as live demonstration of the ANSYS and 3DSIM workflow tools with user input and interactive discussion.

Presenter Name: Robles, Daniel

Presenter Company: Integrated Engineering Blockchain Consortium

Presentation Title: Why Engineers Must Pay Serious Attention to Blockchain Technology (D. Robles, Integrated Engineering Blockchain Consortium; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 1

Room #: Grand Ballroom B

Abstract:

Blockchain technology is the most recent in a wave of technologies overtaking public consciousness. "Disruption" is an understatement as predictions of entirely new monetary and governance systems are the new standard of media hype and horrors. Yet few people realize that Blockchains were invented by engineers - in their own image! This presentation will explain the origin of blockchains, the problem that blockchains solve, current trends, and the enormous opportunity and strategic advantage presented to the engineering profession, if and only if we choose to accept it.

Presenter Name: Roche, PE, Charles

Presenter Company: Western New England University

Presentation Title: Accuracy of Predicting Stress Concentration Factors (C. Roche, PE, Western New England University; Lvl: 1)

Type: Presentation

Keywords: error, accuracy, finite element analysis

Session Title: Simulation Governance: Verification & Validation 2

Session #: 3-3

Room #: 24

Abstract:

Master Degree Students in Civil and Mechanical Engineering were given specific geometries to model in a finite element code to capture theoretical stress concentration factors. Their results were reviewed after some level of support from the instructor. These results may guide managers and practitioners in the accuracy of finite element results in a typical stress analysis study. The author takes the unixial, isothermal results and presents a subset of data for composite materials, biaxiality of stress, and thermal gradients. The expectations should be lowered accordingly as the data suggests. The author speculates in his conclusions regarding level of difficulty, user experience and what a manager should expect. The anlayses presented include the Kt of a hole where the theoretical Kt approaches 2.9 for a finite width plate. This represents the simplest of analyses in that it is effectively two-dimensional, isothermal, uniaxial, and isotropic. Next the Kt of an embedded spheroid where the Kt approaches 2.02 had the same limitations except that it is a three-dimension stress concentration factor. The analytical verification and validation protocol is reviewed. The author presents souces of scatter observed from decades of analyzing and testing isotropic materials. Sources of scatter are expanded to non isotropic materials and should include orthotropy, loading variation, loading alignment, grain boundaries, variation in elastic constants, variation in thermal coefficients of expansion, variation in density, and the like. The type of analysis plays a role in accuracy as well. Buckling prediction presents a challenging example of analytical prediction vs test data. The testing sources of error are listed and can be just as malevolent as finite elment predictions. The author can only present anecdotal data for the more difficult problems found in the real world. Sources of scatter or error are listed and should provoke discussion. An industry can adopt coefficient of variation assumptions in the analytical design cycle to ameliorate structural integrity.

Presenter Name: Ross, Brant

Presenter Company: MotionPort

Presentation Title: On the Correct Preloading of Nonlinear Flexible Bodies to Achieve Accurate Multibody Simulation Results (B. Ross, MotionPort; Lvl: 1)

Type: Presentation

Keywords: System simulation, motion, multibody dynamics, finite element analysis, mechanical system

Session Title: Multibody Simulation 1

Session #: 3-2

Room #: 26C

Abstract:

Multibody simulation has evolved from rigid body dynamics to the analysis of assemblies with both rigid and flexible bodies. These flexible bodies can have large deflections and contact other bodies or themselves. These sophisticated models, if created properly, produce results with much higher fidelity than models that only consider rigid bodies. Sometimes the flexible structure has a deformed (pre-stressed) initial configuration that occurs during the manufacturing/assembly of the product. The simulation model must replicate the initial deformed state of the flexible body in order to obtain accurate results. The challenge is that the starting mesh is in a relaxed state. A series of simulation steps are needed to bring the structure into the correct starting state of deformation. This presupposes that the simulation software is able to save the model, including the deformed structure, at the end of each step such that the model can start each new simulation with the model state from the conclusion of the prior step. An example is the simulation of the flexible boot of a constant velocity (CV) joint assembly that is used on off-highway, all-wheel drive trucks that traverse challenging terrains. In this environment the CV joint can operate with a transmission angle of 40 degrees or more when the steering angle and suspension travel are near their limits. The performance of the CV joint boot is important because it is critical to keep contaminants out of the CV joint. Failures caused by extreme deformation or rubbing on the shaft need to be avoided. The evaluation of rubbing on the shaft as well as the stress in the boot depends on the dynamics of the operating environment, including the effects of imbalance of the boot. While the boot is well balanced as manufactured, during usage it is possible for a quantity of grease to drop from the CV joint and lodge between the folds of the boot. Given the high rotational speeds of the boot, even the small imbalance caused by the grease can be significant. For purposes of validation in this study there is a focus on two comparisons between the simulation results and physical testing. First, when the production boot is rotating with a transmission angle that exceeds the design specification, the outer edges of the top two folds collapse at the outer portion of the rotation, forming dimples. An excellent correlation was observed between the simulation animation results and the photograph from physical testing. Note that the dimpling effect occurs during constant transition. Depending on the transmission angle, there can be transitions between 1 and 2 dimples on a fold or an oscillating behavior between the two folds. The second comparison considers the shape of the boot and the contact between folds. There is an excellent correlation between simulation and test. Given the excellent visual validation there can be high confidence in the other simulation outputs, including stresses and strains. Design insights can result from seeing the evolution of the stress in the boot as the transmission angle of the joint gradually increases. The details of the time and cost savings to the customer from using simulation for CV boot design will be presented. The deployment of a roll-up solar array provides a second example of the importance of proper pre-stressing of flexible bodies in order to obtain correct results for the assembly. In the case of solar arrays, it is important to simulate the both the manufacturing assembly and stowing operations first before simulating the deployment. In conclusion, today's multibody dynamics simulation software provides capabilities to accurately model assemblies of rigid and flexible bodies in motion, including contact. Second, accurate behavior of flexible bodies requires the careful replication of initial, preloaded conditions. Third, substantial savings in cost and time result from the ability to simulate complex assemblies and structures such as can be found in a CV joint boot or a roll-up solar array.

Presenter Name: Röver, Wulf

Presenter Company: Dassault Systemes SIMULIA Corp.

Presentation Title: Gear Whine of Planetary Gear Systems (W. Röver, Dassault Systemes SIMULIA Corp.; Lvl: 2)

Type: Presentation

Keywords: Multi-Body Dynamics, System Analysis, Flexible Gear, Whine, System Response

Session Title: NVH

Session #: 2-2

Room #: 26A

Abstract:

Planetary gear systems are an essential mechanical subsystem in all kind of industry applications, be it in aviation for turbo prop reduction gear sets or the latest airplane turbine designs, in 8 to 10 speed automatic transmissions in the automotive business, or in large machinery for earth moving equipment. For a system engineering analysis tool to be effective in providing input to the design process it need to be accurate and sensitive enough to model parameter changes, fast to be able to impact design decisions, provide system level results to improve the understanding of the system in question, provide a modular structure to improve data management. A system wide analysis cannot be limited to nominal design condition analyses, which do not represent the physical component adequately, but requires to predict the actual response of the system, based on the tolerance stack-up and compliance of the supporting non-moving components (housing & covers), the bearing designs (rolling or journal bearings), the moving components (shafts and gears) and the varying gear contact stiffness for the different loading and boundary conditions. Only analysis software that can address all these influencing factors inside a system analysis environment will be able to provide reliable analysis results, improve the system understanding and will be able to address error states by providing valuable design direction. Basis for this presentation is the DOE study of the system response at the ring gear utilizing a multi-body dynamics analysis model of a single planetary gear system, by evaluating the following influencing factors • The number of planets: 3, 4 or 6 • The misalignment conditions of the carrier (tilting & radial offset) • The misalignment conditions of the ring gear (radial offset) • The influence of a flexible ring gear in comparison to a rigid ring gear The utilized system analysis model is highly parameterized and therefore enables the use of DOE and optimization tools by allowing direct access to the model parameters, like positioning of components, misalignments, offsets, tilting angles, etc. This presentation will highlight, that looking at the analysis results of a nominal configuration of the planetary gear system can misguide the design direction. It might even lead to wrong expectations of the system response of the physical system, to the point that the CAE model and analysis method itself comes under scrutiny, once the system undergoes physical testing, and therefore undermining the benefit of using CAE to predict system behavior. The performed DOE shows that the expectation, based on theoretical equations and assumption, that a system with more planets will have the tendency to provide a beneficial NVH characteristic with lower response amplitudes and less resonance points at lower frequency, is questionable. The analysis results also highlight the importance of putting more emphasis on bringing more detail into the physical representation of the planetary gear system, to capture the specific system response of each design more accurately to be able to make well founded and design decisions early in the process and avoiding costly redesign and 'fixes' after production. The presentation will also show the complete workflow and different aspects of automization for this analysis workflow (e.g.: the automated process for the generation of flexible gears as FE-substructures inside the multi-body dynamics code), which provides additonal efficiency improvements during the system design phase and enables the analyst with the capability to further provide timely input to the early design stage.

Presenter Name: Rüberg, Thomas

Presenter Company: TailSit GmbH

Presentation Title: Robust FEM-BEM Coupling for Electromagnetic Field Computations and Multiphysics Problems (T. Rüberg, TailSit GmbH; Lvl:)

Type: Presentation

Keywords: FEM-BEM coupling, electromagnetic fields, eddy currents, Fast Multipole Method

Session Title: Multiphysics 1

Session #: 2-2

Room #: 25C

Abstract:

Numerical simulation forms an indispensable part of the development cycles of electric machines, magnetic sensors, or transformers---and Finite Element Analysis (FEA) has become the de facto standard for the virtual prototyping of such devices. Whereas FEA seems perfectly suited for, among others, structural analysis problems, the simulation of electromagnetic field problems still poses significant challenges. Since these fields penetrate not only the objects under consideration but also the surrounding space, the FEA requires also a discretisation of a substantial amount of exterior volume. This approach, although common in most commercial FEA software packages, generates several problems: -- The volume discretisation of the surrounding space can only be bounded and therefore requires the creation of artificial boundaries with unknown conditions. This modelling error can affect significantly the accuracy of the simulation. Especially, force and torque calculations in electro-mechanical coupling suffer from this shortcoming. -- The generation of such a volume discretisation typically incurs a considerable amount of time and effort. Often, the number of finite elements in the surrounding region even exceeds the number of elements for the volume discretisation of the solid parts themselves. -- Frequently, devices in electromagnetic field simulation consist of moving parts. If components move relative to each other, standard finite element meshes get distorted, often to the extent of rendering the approach useless. Many techniques exist to circumvent this issue, such as sliding grids, but each of which comes at a cost and has its own restrictions. In this work, we present an approach based on the coupling of Finite Element and Boundary Element Methods (BEM) that resolves the above listed issues. The BEM allows for a highly accurate approximation of the electromagnetic phenomena in the exterior space and solely requires a surface discretisation. Consequently, any discretisation of the surrounding space and related artificial boundaries are completely avoided. More specifically, we use a symmetric finite element-boundary element coupling for magnetostatic and eddy-current problems. This formulation has proven to be robust with respect to large jumps in the material parameters. Moreover, our approach exhibits almost linear complexity due to: -- An optimal preconditioning strategy for the finite element and boundary element system matrices. -- The use of a Fast Multipole Method that reduces the quadratic complexity inherent to a standard BEM down to linear complexity. We demonstrate the validity of our implementation by addressing several benchmark examples for magnetostatic and eddy-current problems. Moreover, the analysis of a eddy-current brake and induction heating are presented in order to substantiate the versatility of the method.

Presenter Name: Safarian, Patrick

Presenter Company: Advanced Aviation Enterprises

Presentation Title: Requirements of Certification by Analysis (P. Safarian, Advanced Aviation Enterprises; Lvl:)

Type: Keynote

Keywords:

Session Title: Keynote

Session #: 3

Room #: Grand Ballroom B

Abstract:

Presenter Name: Salman, Laila

Presenter Company: ANSYS Canada Ltd.

Presentation Title: The Use of Multiphysics Simulation in The Design of Commercial Air Package Delivery Systems (L. Salman, ANSYS Canada Ltd.; Lvl: 1)

Type: Presentation

Keywords: Multiphysics Simulation, Air Package Delivery Systems

Session Title: Multiphysics 1

Session #: 2-2

Room #: 25C

Abstract:

The ongoing challenge for electronic commerce companies is the need to optimize the order to delivery process while minimizing failure. Companies are looking for the most efficient way to deliver their goods to customers and the automation of this process is the solution. Unmanned aerial vehicles, or drones, promise fast and highly individualized delivery of goods. The presented work will demonstrate how to tackle the wide range of engineering challenges that may be encountered at different stages of the drone-based delivery process. Specifically, an electronic order is received at a nearby warehouse for order fulfillment. The delivery process starts with the control unit receiving the electronic order. Once the order is received, several operations are triggered and performed seamlessly to ensure fulfillment of the order. The control unit will call on an idle robot to fetch the goods from their location in the warehouse through RFID tag tracking. Once the goods have been retrieved from the correct shelf and transferred to the shipment area, the items are packaged, and delivery information will be printed and attached to the package. A drone will pick up the package with the information communicated from the control unit about the delivery location. An embedded GPS antenna will guide the drone to the target deliver area. The aforementioned scenario is studied within a harsh RF environment. EMI and EMC problems are identified and studied using ANSYS HFSS, SAVANT and EMIT. Channel integrity between the control unit and the robot, RFID scanner, printer and drone are studied as well as interference from other RF systems that may normally be found in this warehouse environment. Multi-Physics analysis is used to ensure the system can perform under the different physical conditions. Behavioral models of the air in a city are accounted for using ANSYS AIM and CFD and their effect on the drone as it flies to the delivery location are studied. Combined, the work gives an overview of the challenges that can face an e-commerce delivery system and proposes a multiphysics-based solution for tackling these problems.

Presenter Name: Sampath, Ramprasad

Presenter Company: Centroid LAB

Presentation Title: Dynamic Simulation Driven Fire PRA & Visualization at for Nuclear Power Plants (R. Sampath, Centroid LAB; Lvl:)

Type: Presentation

Keywords: CFD, Fire Simulation, PRA, Neutrino, EMRALD

Session Title: CFD 2

Session #: 1-2

Room #: 26A

Abstract:

Fire simulations and visualization in the context of Nuclear Power Plant Risk Analysis remain a challenging task partly due to increased complexity in setting up the 3 D modeling and analysis. However these setups can be greatly simplified by use of a good modeling and visualization environment such as Neutrino (www.neutrinodynamics.com). This talk explores the methodology of coupling Neutrino modeling and visualization environment with FDS (Fire Dynamic Simulator - NIST) and the dynamic probablistic risk analysis (PRA) software EMRALD. The project is jointly under development from Centroid LAB, Idaho National Laboratory(INL - www.inl.gov) with the help of Electric Power Research Institute (EPRI - www.epri.com) and Protection Engineering Consultants (PEC: https://www.protection-consultants.com/) . Centroid LAB has previously worked with INL and EPRI on flooding modeling of Nuclear Power Plants for estimating risk using a combination of probabilistic and computational methods. This will extend that methodology to address the technical elements relevant to fire modeling analysis, such as the selection and definition of fire scenarios and the determination and implementation of input values, sensitivity analysis, uncertainty quantification. In this approach the Nuclear Regulatory Commission (NRC) reports(NUREG 1934 and NUREG-1824) as used as guidelines in conducting such a Fire PRA anaysis. As an example setup, Fire Dynamics Simulator (FDS) is used to emulate a fire induced by a short-circuit from a high-voltage component in a switchgear room of a nuclear power plant and resulting failures and consequences are discussed with visualizations and analysis. 3D CAD models of an existing switch geear room is imported into Neutrino modeling environment and fire sources are setup with their corresponding geographic location. This sample setup also takes into account operator actions and turning on the sprinkler systems as part of the simulation setup. EMRALD software is used to sample operator actions and models how long it would take for an operator to intervene in the process. EMRALD is subsequently coupled with hybrid Neutrino/FDS simulations to produce a realistic scenario of a fire accident progression. GPU-accelerated algorithms using NVIDIA's GVDB library is also used for effective real-time visualization of the scenario.

Presenter Name: Sarkar, Snigdha

Presenter Company: Caterpillar Inc.

Presentation Title: Pressurized Air Tank Oil/Air Separation Efficiency Study (S. Sarkar, Caterpillar Inc.; Lvl: 2)

Type: Presentation

Keywords: Oil/Air Separation, ANSYS, Discrete Phase Model, CFD Simulation

Session Title: CFD 2

Session #: 1-2

Room #: 26A

Abstract:

Caterpillar is developing compressed air tanks for drilling application in mining division. One of the main challenges in air tank design is to effectively separate and remove lubrication/cooling oil from air stream, to reduce end customer operating cost. Caterpillar teamed up with ANSYS to simulate oil/air separation process using DPM (Discrete Phase Model) on multiple tank designs, to understand and improve oil/air separation efficiency. A 3D CAD model representing the tank interior as well as the discharge pipe was created and meshed. The mesh was imported into ANSYS FLUENT to setup material flow rates and boundary conditions. Since, the flow spirals through this tank, the choice of turbulence model is important. Realizable ke model with curvature correction is used to capture the turbulence in the flow field. Air is modeled as an ideal gas. In order to capture areas with high gradients, dynamic mesh adaption is used. After establishing a converged airflow path, oil droplets of a uniform diameter are introduced from the inlet, and are tracked in a coupled manner. A standard parcel release method is used to define the oil injection. Numerical techniques are used to under-relax and smooth out source terms. Unsteady tracking of discrete particles is coupled with steady airflow in order to model wall-film formation. Droplet film formation is captured at impingement walls, and subsequent stripping and separation of oil film is included. The KHRT model is used to model airborne breakup of oil particles. The capture efficiency is measured once steady state conditions are reached by monitoring the droplet flow rate across the top and bottom outlets. Droplet diameter and tank height are varied in subsequent simulations, to study their impact on the droplet flow rates across the outlets. Results are used to predict and correlate oil/air separation efficiency in tanks with different designs. Oil/air separation efficiency trend predictions are in good agreement with field data.

Presenter Name: Sarkar, Saurabh

Presenter Company: ESSS

Presentation Title: Next Generation Discrete Element Modeling: Introduction and Its Application (S. Sarkar, ESSS; Lvl:)

Type: Training

Keywords: Discrete Element Modeling

Session Title: Next Generation Discrete Element Modeling: Introduction and its Application

Session #: 2-1

Room #: 21

Abstract:

Discrete Element Method (DEM) based first principle modeling can be used to improve insight for a wide range of particulate processes. Current and prospective users are encouraged to be aware of the start of the art DEM features and how it can be used to solve practical problems. The training course would demonstrate a sample case to highlight how a software like Rocky DEM ® can be used to understand and optimize processes. The training would begin with a basic introduction to DEM methodology clearly outlining the fundamental principles and assumptions. Next, real world value would be demonstrated through a practical case of pharmaceutical tablet coating in a drum coater. Tablet coating is often a very costly multivariate unit operation to optimize and scale up. Practical use of DEM would be highlighted through the following steps: (a) Setting the geometry - Importing and exporting CAD files including custom particle shapes (b) Setting up process parameters - A brief overview on how relatively simple to complicated equipment motions and particle flow rates can be prescribed. (c) Material Properties – This is a critical part of a DEM case set up. This section would highlight the different user inputs needed, including interaction parameters between different materials (particle-particle, particle-boundary etc.). Good practices for model calibration would be briefly discussed. (d) Hardware selection: Prior to beginning the numerical solution, guidelines for hardware selection based on the case at hand would be presented. (e) Post Processing: After the calculation is complete, post processing tools to enhance process insight would be discussed. Specific to this case, 3D visualization of tablet mixing and velocity profiles, shear stress and volume distribution using Eulerian statistics, and basic plotting tools would be demonstrated. Furthermore, calculation of residence time distribution in a specific volume (spray zone) to predict coating variability and estimate processing times would be shown.

Presenter Name: Sarkar, Saurabh

Presenter Company: ESSS

Presentation Title: Large Scale Discrete Element Modeling for Various Process Equipment (S. Sarkar, ESSS; Lvl:)

Type: Presentation

Keywords: Discrete Element Modeling

Session Title: Multiphysics 4

Session #: 3-3

Room #: 21

Abstract:

Process development involving particulate solids can often be challenging to optimize and scale up. This is largely because of underlying complicated physical phenomena which are not well understood. Conventional attempts to map the dynamic interplay of process, material and geometric variables include executing large scale design of experiments (DOE) based studies, which consume expensive time and material resources. The heavily regulated pharmaceutical industry is a typical example, where establishing and demonstrating process understanding can take few years and millions of dollars. An attractive alternate method for improving process understanding of particulate processes is through predictive first principle modeling using the Discrete Element Method (DEM) approach. With beginning in civil engineering applications for predicting soil failure in the late 1970s, DEM has rapidly grown into multiple industries including mining, agricultural, food, chemical etc. with numerous success stories. The reason for increasing acceptance of DEM a sound physical basis – computing all relevant forces acting on all particles and numerically integrating it to obtain updated velocities and positions in accordance to Newton's laws of motion. However, some practical challenges in implementing this approach have impeded even greater penetration of DEM into process centric industries. Notable challenges include (a) Hardware restriction: As each particle is explicitly accounted, the problem is computationally intensive with the size of problem dependent upon number of particle contacts. Often a 1: 1 particle scale matching is not practical and larger particle sizes need to be used, a practice which is justified by calibrating material properties accordingly with experimental validation. (b) Software Sophistication: Detecting contacts between irregularly shaped particles can be quite cumbersome, and most commercial codes "glue" spheres to achieve a desired shape. This approach has known flaws, example introduction of artificial friction, and a risk to benefit ratio must be evaluated before running such cases. Robust coupling with continuum based methods (CFD and FEM) is another challenge. Rocky DEM® provides state of the art features in overcoming these limitations through the use of proprietary multi GPU technology to solve for large systems and accurate shapes, with coupling if needed, and has been used to solve practical problems and provide value. The current abstract highlights utility of good DEM modeling to address challenges in process development in the pharmaceutical industry. Computational optimization of tablet coating in a commercial scale BFC tablet coater (359 kg batch containing 250,000 tablets with realistic polyhedral shapes) was undertaken for process understanding and optimization, especially with regard to mixing patterns and residence time distribution within the spray zone which are directly to coating variability. Each simulation took approximately 3 days on 3 NVIDIA Tesla 100 GPU cards, which is about 86 times faster than an 8 core CPU. Enhanced process understanding was also obtained for high shear wet granulation process, which is used to improve flow and compressibility of solid oral formulations. This process has known difficulties in scale up and the objective of this study was to establish correct scale up rules through dynamic process understanding for cases involving dry and wet placebo. Granulators at 1L,10L and 150 L scales were simulated and validated against experimental data. Multi GPU solvers enabled modeling of realistic particle size distributions and simulate over 10 million particles. Detailed process insight was obtained through extensive post processing wherein velocity, stress and residence time distribution and collisional behavior, volume fractions etc. were obtained; information which is otherwise extreme difficult to obtain experimentally. Ultimately, the desired objectives were met using DEM based modeling and reduced DOE burden at a fraction of the cost.

Presenter Name: Savic, Vesna

Presenter Company: General Motors Corporation

Presentation Title: Integrated Computational Materials Engineering (ICME) Approach to Model Development and Vehicle Lightweighting with Advanced High Strength Steels (V. Savic, General Motors Corporation; Lvl: 1)

Type: Presentation

Keywords: integrated computational materials engineering, multi-scale modeling, lightweighting, advanced high strength steels

Session Title: Lightweighting

Session #: 1-3

Room #: 25A

Abstract:

This presentation will cover a development of a multi-scale material model for a 3rd Generation Advanced High Strength Steel (3GAHSS) based on integrated computational materials engineering principles (ICME Model). Following a brief overview of the ICME project, a material model development will be described. The model combines micro-scale material properties defined by the crystal plasticity theory with the macro-scale mechanical properties, such as flow curves under different loading paths. For an initial microstructure the flow curves of each of the constituent phases (ferrite, austenite, martensite) are computed based on the crystal plasticity theory and the crystal orientation distribution function. Phase properties are then used as an input to a state variable model that computes macro-scale flow curves while accounting for hardening caused by austenite transformation into martensite under different straining paths. The ICME model calibration is implemented in the LS-OPT analysis tool as a component of an optimization process. The final result of the ICME Model calibration is a user-defined material subroutine, implemented in LS-DYNA finite element analysis software. A design optimization of a vehicle structure using the multi-scale ICME Model will also be presented. Design optimization of a vehicle body side structure was conducted using the new grades of 3GAHSS with the objective to minimize mass while maintaining key structural performance at par with the body structure used as a baseline. Shape optimization of main structural members was performed together with the optimization of part thickness and material selection. Optimization results show a 30% mass reduction potential of a mid-size sedan body side structure with the use of 3GAHSS. Design optimization steps, as well as the challenges in application of ICME models in vehicle design integration and optimization will be addressed. The presentation will conclude with integration steps that are needed to enable vehicle performance metrics driven material development in terms of chemical composition and phase characteristics.

Presenter Name: Sederberg, Matthew

Presenter Company: Coreform LLC

Presentation Title: Isogeometric Analysis for More Accurate Simulation (M. Sederberg, Coreform LLC; Lvl: 2)

Type: Presentation

Keywords: IGA, FEA, isogeometric analysis, U-splines

Session Title: CAD / CAE

Session #: 3-3

Room #: 26B

Abstract:

In contrast to the laborious and error prone process of translating computer-aided design (CAD) into computer-aided engineering (CAE) models, isogeometric analysis (IGA) performs the finite element analysis (FEA) simulation directly on smooth CAD geometry. IGA was first invented over 10 years ago, and is now the most active academic field of FEA, with over 1500 papers published. There are multiple IGA-specific conferences held annually. IGA consistently performs faster and more accurately than FEA, and is more robust. Some of the benefits of IGA include More accurate simulation, since analysis is run on the actual smooth geometry, not an approximation, and higher-order smooth basis functions are employed. Time saved from preparing the mesh. Time saved in actually running the simulation itself, especially for hard problems. Integration with CAD to enable fully integrated design iteration. More realistic post-processed results on the CAD geometry, which help convey the analysis results better to non-experts. In this presentation, the idea of IGA will be introduced, motivation for IGA will be presented, and key commercial results will be shared. In the past few years, IGA has begun to be commercialized, with implementations of varying stages in LS-DYNA, RADIOSS, and other software. Coreform LLC was also formed with the express purpose of commercializing IGA and inventing a new geometry type, U-splines, that is suitable for both CAD and CAE, which is the key for unlocking the commercial potential of IGA. U-splines simulation results will be shared and compared against traditional FEA results. Various workflows of how to integrate IGA into commercial processes will be shared. Examples of IGA models created directly from FEA meshes and CAD data will be shared. Attendees at this presentation will come away with an understanding of what IGA is and an appreciation of the fundamental improvement it might make to the simulation industry.

Presenter Name: Seidensticker, David

Presenter Company: MSC Software

Presentation Title: Multidisciplinary Analysis of Wind Turbine Blades (D. Seidensticker, MSC Software; Lvl: 1)

Type: Presentation

Keywords: Multidisciplinary Analysis, FEA, Aerodynamics, Manufacturing, Composites, Cloud Computing, DMDII

Session Title: Advanced Composites

Session #: 1-1

Room #: 25A

Abstract:

Structural simulation has traditionally been a discipline performed by analysis engineers in isolation from other groups during the design and manufacturing process. However, design choices made to ensure structural integrity have ripple effects throughout the manufacturing process, affecting the manufacturability, cost, and ultimate profitability of a product. The Digital Manufacturing and Design Innovation Institute (DMDII) has funded partnerships between industry, academics, and software experts to break down traditional barriers and better enable digital integration throughout the manufacturing process, with the goal of producing a more streamlined, optimized, and ultimately democratic production cycle. A recently completed project called BladeMDA, focusing on composite wind turbine blades, was funded to create a usable cloud-based tool that enables and promotes communication between engineering, manufacturing, and business units from the earliest design cycles. The team focused on turbine blades as a relatively straightforward product with sufficient complexity to demonstrate the advantages and capabilities of the approach, but with some effort it could be adapted to a wide variety of different products and processes. For the BladeMDA project, multiple, powerful analysis codes were integrated into a single automated model environment built on a lightweight Java-based platform and hosted on remote computing resources. The architecture and user interface eliminate the need for model translation across analysis packages and simplify the learning curve required to operate advanced structural and fluid dynamics codes, while allowing users on heterogeneous devices throughout an organization to easily share the same development tool as they collaborate on the product design. The completed specifications can be directly used on the shop floor within the same software environment to access fully digital work instructions that are generated automatically. This linkage of codes is modular and easily adaptable to other composite forms. Additional codes can readily be linked in for specialized domain feedback such as structural dynamics or rotor downwash. The result is a design that at each stage of the process is optimized for cost, manufacturability, and functionality, as the vision is realized in a detailed specification and physical product.

Presenter Name: Sengupta, Jeet

Presenter Company: Hoerbiger Corporation of America, Inc.

Presentation Title: Digital Characterization of the Injection Molding Process – Verification and Validation (J. Sengupta, Hoerbiger Corporation of America, Inc.; Lvl:)

Type: Presentation

Keywords: Injection Molding, manufacturing process, validation

Session Title: Simulation Governance: Verification & Validation 1

Session #: 3-2

Room #: 24

Abstract:

Injection molding is a manufacturing process which produces parts mainly out of thermoplastic material. It allows mass production of complex shapes with precise dimensions and covers a wide product range from part weighing a few milligrams to over 150 kg, with a fast process cycle time ranging from seconds to just a few minutes. Over the last several decades it has become an attractive manufacturing process for a wide variety of applications from automotive to white goods to toys. It's a process that has been successfully employed to produce reciprocating valve sealing elements. However, since polymers are non-Newtonian the small changes in viscosity can often necessitate process modifications to produce a defect free part. Thus, modeling the injection molding process is a cost effective alternative to optimize the process operating window to produce defect free parts instead of doing it at the molding machine. However, it is a suitable alternative only if the model has predictive capabilities and any predictive model would need a significant amount of validation. This paper presents the work done in the validation and verification process to calibrate a computer model that can capture the injection molding manufacturing process. For simplicity, the stock shape used for model development is a circular flat disc. The work done here is focused on the high pressure high temperature engineering thermoplastic – PEEK. The paper compares the injection pressure and the mold cavity pressure with measured data and qualifies the reasons for differences if any. Measurements were accomplished using RJG Inc.'s proprietary eDart system. Additionally mold temperatures predicted by the model were also compared against the measured data. A shrink and warp study was performed to determine the process induced residual stresses and were quantified using displacement as the metric. These were then compared against the measured flatness to calibrate the model.

Presenter Name: Senousy, Mohamed

Presenter Company: ANSYS Inc.

Presentation Title: Multiphysics Modeling of Layer Deposition Process and End Product Failure in Metal Additive Manufacturing (M. Senousy, ANSYS Inc.; Lvl: 2)

Type: Presentation

Keywords: Metal, Additive Manufacturing, Multiphysics Modeling, CFD, FEA, Melt Pool, Failure

Session Title: Additive Manufacturing Process Analysis 1

Session #: 1-1

Room #: 25B

Abstract:

Additive manufacturing, commonly known as 3D printing, has been gaining popularity at unprecedented speeds. This is due to the many benefits it offers such as little to no assembly of parts, complex design manufacturability and customization. This technology is being utilized in aerospace, biomedical and other areas of industry. However, it requires precise control over physical processes of rapid heating, melting and cooling to impart desired properties for a particular application. It is this need that requires a careful study of the thermo-physical processes that occur during the manufacturing. In the current work, we have used ANSYS Fluent computational fluid dynamics software to simulate some of these processes. This is demonstrated via metal layer deposition from a solid wire feed on a flat plate. The process is similar to welding where the solid feed melts under a laser and deposits a molten pool of material on a substrate. Modeling of this process involves moving laser and wire feed, heat transfer within molten and solid metal, solidification and melting of metal feed as well as free-surface Volume-of-Fluid (VOF) modeling of the interface between metal and surrounding air. Results show the size of the melt pool and quality and size of the deposited layer. Influences of multiple process variables such as laser power, laser travel speed and wire feed rate can be understood from such simulations. Other processes can also be included such as magnetic field assessment to guide and control the Magneto-Hydrodynamics in the molten pool. Electromagnetic fields are calculated in the ANSYS Maxwell solver. In addition to modeling the details of layer deposition process described above, simulations can help mitigate end product defects and failures. Uncontrolled exposure to laser power may lead to defects and waste due to part melting. Distortion and residual stresses may occur due to rapid heating and cooling of parts in the printing process. In an uncoupled approach, the printing process is simulated using ANSYS Mechanical FEA software to provide good trend estimation of residual stresses and distortion that helps prevent early fatigue/fracture failure. A transient thermal analysis is performed, which is critical for predicting an accurate temperature distribution affecting both residual stresses and distortions, followed by a one-way coupled structural analysis. Metal additive manufacturing users ranging from printer manufacturers to component design engineers would benefit from such complete multiphysics computational solutions to optimize layer deposition process and to predict potential mechanical failures.

Presenter Name: Shah, Harsh

Presenter Company: Wichita State University

Presentation Title: CFD Simulation and Wind Tunnel Test Correlation for a Tailless Multi-Variant sUAS (H. Shah, Wichita State University; Lvl: 1)

Type: Presentation

Keywords: sUAS Design, CFD, FloEFD, Wind Tunnel correlation

Session Title: CFD 2

Session #: 1-2

Room #: 26A

Abstract:

The present work describes the use of the CFD software – FloEFD during the conceptual and preliminary design of the tailless multi-variant sUAS which is being developed at the National Institute for Aviation Research (NIAR). The sUAS will act as a technology demonstrator to showcase the capabilities of NIAR in design, analysis and manufacturing. It has a pusher configuration and is designed to cruise at 50 mph with a maximum take-off weight of 55 lbs. It relies on electric propulsion for VTOL flight and on piston engine propulsion for forward flight. As it does not have a tail, its longitudinal stability is dependent on the reflex shape of the airfoils and the wing sweep angle. Multiple design iterations are carried out on a parametric CAD model to size the wings and to achieve a nearly trimmed condition for the cruise flight regime. The aerodynamic characteristics of the final configuration of the sUAS are presented here. A one-third scale Wind Tunnel model is fabricated using additive manufacturing techniques and is tested at the NIAR Walter H. Beech Wind Tunnel. A comparison between the CFD results and the Wind Tunnel test results is made. The CFD simulations are performed for cruise conditions (V = 50 mph, Re ? 750,000). The aerodynamic parameters are calculated for an angle of attack range of -10° to 13° (? = 0°) and for a sideslip angle range of 0° to 25° (? = 0°). The results for sideslip angle range of -25° to 0° are assumed to be symmetric. The thin boundary layer approach and the solution adaptive refinement approach are used in this study. The mesh size is approximately 4.5 million cells at the end of all the refinements. Results are compared to the wind tunnel test results which are performed at the same Re ? 750,000. The computational domain, mesh plots and correlation of results are shown in the figures below. It is seen that there is a very good agreement between the FloEFD simulation results and the Wind Tunnel test results at small and moderately high angles of attack and sideslip angles. It is evident from the results that the sUAS possesses natural static stability about all its axis (negative Cm – ? slope, positive Cn – ? slope and negative Cl – ? slope). At higher angles of attack and sideslip angles, there is a deviation in the results predicted by FloEFD and wind tunnel data. Efforts are being made to improve the existing CFD model.

Presenter Name: Shah, Aditya

Presenter Company: John Deere

Presentation Title: Custom Integration Framework for MBSE and CAE Using Open Standards (A. Shah, John Deere; Lvl: 2)

Type: Presentation

Keywords: open source, mbse, simulation, integration, linked data, interoperability

Session Title: Emerging Standards

Session #: 2-1

Room #: 26C

Abstract:

As the fields of Model-based Systems Engineering (MBSE) and Computer Aided Engineering (CAE) continue to grow in order to support increasingly connected and complex product development, there is an increasing need to connect these two disciplines together. The role of MBSE models has evolved to support analysis in addition to visual diagrams, as evidenced by SysML v2 efforts. CAE models, such as dynamic systems simulations, are increasingly focused on system level interactions. Therefore there is an opportunity to use MBSE as a platform to connect different disciplines together such as requirements, architecture, simulation models, etc. However, the diverse set of tools and proprietary data formats / data models / APIs makes such integration hard. Traditional solutions rely on point to point integrations between tools and development of custom workflows. Moreover, the data is siloed within tools and is not easily linked, increasing the chance for inconsistency. Instead of such custom integrations, we propose to use open web standards such as linked data, ontologies, triple store databases to extract data and data models from tools in a neutral format. Along with the neutral format we propose to use open source software for revision control and continuous integration to create workflows that automate the execution of such interconnected models. One example is linking requirements with dynamic systems simulations. The key pieces in this environment are the APIs provided by tools and common data models (also referred to as ontologies) that exist irrespective of the tool used. In this way we will conclude with a future vision in which tool vendors are encouraged to provide APIs that make it easier to access the underlying data models and end users (i.e. companies) are empowered to own their data instead of being siloed in a multitude of tools or monolithic platform solutions from large vendors.

Presenter Name: Shaxted, Matthew

Presenter Company: Parallel Works

Presentation Title: Welding Cloud Computational Applications for Digital Manufacturing (M. Shaxted, Parallel Works; Lvl: 2)

Type: Presentation

Keywords: Welding, modeling, simulation, finite element analysis

Session Title: Simulation of Manufacturing Methodologies & Processes: Welding

Session #: 1-3

Room #: 25C

Abstract:

Welding is an important manufacturing process used in a broad range of industries and market sectors, including automotive, aerospace, heavy manufacturing, medical, and defense. It is a critical core competency that enables these industries and market sectors to support design innovation, with significant positive impact to employment, national security, the environment, and the general US economy. Designing, fabricating, and testing a weld structure to meet the application requirements generally is a time consuming and costly process. Welding processes often result in the softening of the weld heat affected zone (HAZ), complicating prediction of the weld performance. Welding processes also induce residual stress and distortion in the welded structures, further complicating the implementation of new materials and weld designs. Through weld modeling technology development, welding process parameters, fixtures, and tooling can be optimized to reduce the HAZ softening and minimize weld residual stress and distortion, improving performance and reducing design, fabrication and testing costs. However, weld modeling technology tools are currently accessible only to engineers and designers with a background in finite element analysis (FEA) who work with large manufacturers, research institutes, and universities with access to high-performance computing (HPC) resources. Small and medium enterprises (SMEs) in the US do not typically have the human and computational resources needed to adopt and utilize weld modeling technology. To close this gap and address the need of SMEs to gain access to this important design tool, online welding software modeling tools for digital manufacturing using the cloud for high performance computations were developed. The tools use three-dimensional (3-D) models and be applicable to the three most common types of welding processes: arc welding, laser welding, and hybrid laser arc welding. Standard weld joints (butt joint, T-joint, and lap joint) will be included in the software tool. Open source finite element codes were used as a solver for welding process simulation. This tools are hosted in Ohio Supercomputer center. A user can access these tools online and submit computational jobs, which will be run in supercomputers. This presentation introduces the theory and implementation of automatic meshing generation, weld module, weld application interface, open source solver, and automatic post-processing. Simulation examples were demonstrated to illustrate how to use these tools to solve real-world problems.

Presenter Name: Sherman, Bob

Presenter Company: The Procter & Gamble Co.

Presentation Title: System Engineering for the Mass via Canonical Systems Model (B. Sherman, The Procter & Gamble Co.; Lvl:)

Type: Presentation

Keywords: MBSE, Systems Enginnering, Requirements Management, Procter & Gamble, Enterprise Integration, MBSE Transformation, SysML, Rhapsody

Session Title: Systems Simulation 1

Session #: 2-2

Room #: 26C

Abstract:

"System Engineering for the Mass via Canonical Systems Model Increasing product, supply chain and manufacturing complexity have driven industry to begin pursuing “Model Based System Engineering” (MBSE) tools and processes to optimize new product development. To this end, the past decade of development in systems engineering (SE) methods, standards and tools has resulted in many new foundational MBSE capabilities (e.g. ISO:15288, SysML, FMI, OSLC, and countless other invaluable standards). However, these capabilities have typically been applied in a bottom-up fashion to deliver benefits within the classic software and engineering disciplines. As a result, systems models often leave out many disciplines and fall short of the degree of abstraction required to support cross-discipline collaboration on the requirements of systems and the resulting models are often too solution-oriented to enable broad-scale re-use of the fundamental underlying technical knowledge in future, up-stream innovation work. Further, systems modeling tools generally lack the simple, but powerful user interface to provide basic answers to basic change impact and requirements trade-space questions posed by “the masses” (non-MBSE experts). Last, but not least, the complexity of the meta-models and user interfaces in use by today’s systems engineering tools require an “adoption activation energy” not available in today’s quarterly-profit-chasing mindset. To tackle the above challenges, P&G partnered with leading-edge systems engineering method suppliers (e.g. ICTT, BigLever), leading-edge tool suppliers (e.g. IBM, TomSawyer, The ReUse Company, Modelon, etc.) and systems modeling tool configuration expertise (321gang). After two years of development and multiple pilots, we have taken a big step forward in providing the canonical systems modeling and analysis capabilities to deliver systems engineering capabilities to “the masses”. The resulting method and tools are usable by personnel at all levels of the enterprise, in all disciplines, throughout all phases of an initiative’s lifecycle. This presentation will review the key strategies and decisions behind the break-through new capability and some elements of the solution will be demonstrated."

Presenter Name: Shibata, Ichiro

Presenter Company: Altair Japan

Presentation Title: Towards a Digital Twin (I. Shibata, Altair Japan; Lvl: 1)

Type: Workshop

Keywords: digital twin, machine learning, simulation, predictive maintenance, predictive analytics, optimization, prescriptive analytics, 3D printing, IoT, IIoT

Session Title: Towards a Digital Twin

Session #: 3-2

Room #: 22

Abstract:

One of the most promising effects of IIoT introduction is predictive maintenance (PdM). This is because if equipment failure can be predicted with high accuracy, facility availability increases, resulting in productivity improvement. PdM has been studied over the past decades to avoid unexpected equipment failures and to optimize the plan of operation and maintenance in large-scale plants. Due to the recent IoT trend, an environment that can easily introduce the flow from sensor installation to data collection and monitoring was provided. In addition, development of machine learning algorithms such as deep learning has dramatically progressed, and the possibility of data mining utilizing the collected big data has significantly increased. As a result, attention has also been drawn in relatively small-scale manufacturing industries that have not been able to fully deal with predictive maintenance without IoT. However, predictive maintenance cannot be realized merely by measuring the state of the machines and accumulating the data. It is necessary to know the degradation characteristics of the mechanical elements, to grasp the influence of the operation condition, and to comprehend the correlation between the measurement data and the failure, and generally involve mid to long-term research tasks. Therefore, companies that do not have sufficient technical capabilities sometimes failed to achieve the expected effect of introducing IIoT. In traditional machine design, engineers didn't consider predictive maintenance in design phase, and predictive maintenance targeted at installed machines was thought to be an passive activity. This fact is one of the causes of making predictive maintenance difficult to realize. In this workshop, we would like to propose a front loading design for predictive maintenance that makes maximum use of Digital Twin. Design optimization is carried out from the concept design phase considering measurement conditions, training of AI is performed by utilizing measured data in the cyber system to predict equipment abnormalities and mechanical failures, in addition, by performing the correlation analysis with the test results in the physical system, it is possible to realize an efficient optimum design aiming for predictive maintenance.

Presenter Name: Simoni, Darren

Presenter Company: Adaptive Corporation

Presentation Title: Emerging Vehicle Terrain Interaction Modeling & Simulation Techniques for High Fidelity Vehicle Dynamics (D. Simoni, Adaptive Corporation; Lvl: 2)

Type: Presentation

Keywords: Multibody body dynamics, MBD, discrete element method, dem, vehicle dynamics, simulation, terrain, mobility, off-road, automotive, soft soil

Session Title: Multibody Simulation 2

Session #: 3-3

Room #: 26C

Abstract:

Problem Statement: Vehicle dynamics simulations are heavily replied upon in commercial and military automotive industries for design assessment and predictions of performance, including mobility capabilities. Vehicle terrain interaction has challenged vehicle dynamics modeling and simulation tools and users since the adoption of simulation. Generating results on terrains which are comprised of soft, loose, or compacting soils have long been categorized as impossible. Due to these limitations, vehicle dynamics simulations of all vehicle types, including off-road vehicles, are limited on pavement or hard packed type surfaces. Motivation: The complex nature of the physics occurring within terrain materials and its behavior as it interacts with a vehicle has been difficult for experts and researchers practicing in the field of multibody dynamics to develop an accurate general purpose formulation that accounts for all vehicle geometry and terrain types. The few general purpose formulations implemented have been empirically based and limited to hard packed soil often require further custom modification to account for additional effects such as damping and compaction. However, exciting innovative advancements are emerging bringing the vehicle dynamics community very close to a practical, accurate and scalable solution for vehicle terrain interaction modeling and simulation. Approach: This presentation will provide results of recent studies using emerging techniques and demonstrate additional innovative strategies developed to further advance modeling and simulation capabilities of vehicle terrain interaction. A brief introduction to terra-mechanics modeling with DEM software will be included highlighting the characterization of soils and the resulting soft vs hard, loose vs sticky, and compacting behavior; as well as the development of terrain surfaces. An introduction to the general process of coupling MBD and DEM models and solvers (implemented using MSC Adams and EDEM software) will also be covered as background info for users of traditional MBD based vehicle dynamics. Conclusion: Concluding remarks will point out the benefits realized after studying emerging vehicle terrain interaction modeling techniques and the advantages of strategies developed.

Presenter Name: Slavetinsky, Steffen

Presenter Company: Renumics GmbH

Presentation Title: The Deep Learning Revolution and Its Impact on Computer Aided Engineering (S. Slavetinsky, Renumics GmbH; Lvl: 1)

Type: Presentation

Keywords: Deep Learning, AI-guided Simulation, Democratization, Digital Twin

Session Title: Advanced Information Technologies

Session #: 3-3

Room #: 25A

Abstract:

Computer Aided Engineering (CAE) methods have been a remarkable success story over the last decades and have become an invaluable for product development in many industry sectors. However, the adoption rate and growth of CAE has significantly slowed down during recent years. In many applications, especially in the realm of small and medium sized enterprises (SME), significant obstacles exist that impede the efficient use of CAE tools: Huge time investments for manual tasks, significant license costs and the deep numerical expertise that is required in order to set-up CAE workflows. In the last couple of years, machine learning methods based on deep artificial neural networks (deep learning) have achieved tremendous success in many applications. These systems that are often referred to as a form of artificial intelligence (AI) in the media and have already gained superhuman performance in a variety of tasks such as image recognition, lip reading or playing Go [1][2][3]. With the ability to automate processes purely based on large amounts of sub-symbolic data, deep learning is currently revolutionizing many industries. Although deep neural networks for geometry understanding are still a topic of rapidly progressing research, the available methods can already be used to automate many routine tasks within CAE workflows [4]. By reducing the amount of manual routine work in steps such as geometry preparation, meshing, simulation monitoring and post-processing, simulation results can be obtained faster and cheaper. This can speed up developing cycles and strengthen simulation-driven design workflows. Moreover, by fully automating CAE processes, they can be packaged into easy-to-use simulation apps. In this way, CAE becomes accessible to design engineers and small development teams in SMEs. Also, automation is key to establish simulation methods in areas outside of product development and enable physics based digital twins that can be used to optimize machine parameters or maintenance cycles. The talk will discuss the current state of deep learning-based CAE automation and possible future implications of the technology for the CAE community. In particular, the following aspects will be covered: 1. Applications and use cases Along with a general discussion of applications for deep learning in CAE, practical use cases will be presented that cover geometry preparation, post processing and optimization. 2. Technology and software platforms Current approaches to AI-based geometry understanding are briefly introduced and their abilities and limitations are discussed. Furthermore, relevant software frameworks and platforms for building AI-powered workflows are presented. 3. Role of the numerical analyst in the age of AI-powered simulation apps In addition to setting up and performing simulations by themselves, numerical analysts will soon assume additional responsibilities: They will create, manage and supervise highly automated, AI-powered workflows. In this context, we discuss the necessary skillset for these kinds of tasks. 4. From service to product – the business side AI-powered process automation is inherently customer and application-specific. That means that deep learning will accelerate the movement from powerful, monolithic, one-size-fits-all simulation packages towards small, application-specific, easy-to-use software tools. We discuss opportunities for vendors, consultants and users in this scenario.

Presenter Name: Solomon, Robert

Presenter Company: Dassault Systemes SIMULIA

Presentation Title: New Opportunities for Customers Using Simulation Realtime (R. Solomon, Dassault Systemes SIMULIA; Lvl:)

Type: Presentation

Keywords: Virtual Testing using Realtime Simulation

Session Title: Real-Time Simulation

Session #: 3-2

Room #: 26B

Abstract:

This presentation will outline/ position the technologies of HIL (Hardware in the Loop) SILS (Software In the Loop), and DILS (Driver In the Loop). Moving forward in the presentation there will be examples of how these simulation technologies are part of the innovation for many companies. Example 1; how realtime simulation is being used for evaluation of complex full vehicle driveline quality assessment through the use of coupling realtime Vehicle Simulation to Engine Dyno System. Example 2; realtime simulation used for evaluation of supplier technology for vehicle driveline early in the vehicle concept program. Example 3; Autonomous / ADAS realtime modelling connecting to vehicle dynamics performance. Conclude with presentation of future technology developments as maturity of virtual vehicle test processes improve.

Presenter Name: Som, Probal

Presenter Company: Ansys India

Presentation Title: Field Meta-Model Based Multi-Objective Shape Optimization of 3-Pass Exhaust Muffler (P. Som, Ansys India; Lvl: 2)

Type: Presentation

Keywords: Exhaust muffler, backpressure, transmission loss, noise attenuation, multi-object optimization, multi-disciplinary optimization, field meta-model, meta-model based optimization.

Session Title: Acoustics

Session #: 2-3

Room #: 26A

Abstract:

3-pass exhaust mufflers are successfully used in exhaust systems to reduce the noise caused by exhaust gases from engines. Optimized geometric design of the muffler has always been a challenge and an active research area in the industry. Muffler should be designed to satisfy conflicting demands of two major design objectives - transmission loss and back pressure on engine. Transmission loss represents the exhaust noise attenuation by muffler and back pressure represents the additional pressure drop which is created by insertion of muffler in the exhaust system. Designers are tasked with maximizing the noise attenuation with minimum increase in back pressure. Various geometric and operating design parameters are considered to obtain a trade-off between these two conflicting design objectives. These geometric design parameters include porosity of perforated elements, lengths of end cavities, expansion chamber diameter etc. Number of studies can be found where deterministic approaches were taken to find an optimum design between the targeted noise attenuation and backpressure. But all the previous studies are performed separately with calculation of backpressure in CFD and transmission loss in FEM/BEM. However, a complete multi-objective multi-disciplinary optimization approach to find the optimum geometric configuration of muffler is still in need where two conflicting objectives i.e. transmission loss and backpressure can be balanced at the same time. In the present study, transmission loss and backpressure drop are simultaneously optimized to find an optimum geometric design and configuration of a 3-pass muffler. The results are compared with a deterministic case study to show the effectiveness of the stochastic design optimization approach. Additionally, tuned muffler is always a challenge to design. An attempt has been made in this paper to tune the current muffler model by benchmarking the transmission loss spectrum with a target design spectrum. A field meta-modelling based optimization technique is used to minimize the root-mean-square error (RMSE) between transmission loss frequency spectrum curve of current model and design target. This current approach will typically reduce the muffler design development time to couple of weeks from months.

Presenter Name: Som, Probal

Presenter Company: Ansys India

Presentation Title: Spectral Analysis of Aeroacoustic Noise Using CAE Tools (P. Som, Ansys India; Lvl: 2)

Type: Presentation

Keywords: Wavenumber frequency spectra, Aeroacoustic, Automotive noise

Session Title: Acoustics

Session #: 2-3

Room #: 26A

Abstract:

The spectral representation of near field microphones will have significant contributions from hydrodynamic pressure. It is important to know the convective and acoustic contribution so as to relate radiating part as well as the part corresponds to structural excitation from the spectra. In general, the acoustic waves for given frequency can be identified on wavenumber space as k=2*pi*f/c and so the convective wave using kc=2*pi*f/Uc. Here c is speed of sound and Uc is mean free stream velocity. Most often, automotive simulations are focused on speed corresponds to Mach number less than 0.1 and hence for automotive cases the the acoustic and turbulent wavenumbers are di?erent from a factor 10 (Arguillat et al) As the sound velocity is one order of magnitude larger than the convective turbulent velocity, as a matter of convenience, it is possible to separate aerodynamic pressure fluctuations from acoustic ones by wavenumber vectors. It is observed before that Acoustic wavenumber in general of same order of magnitude that of to the ?exural wavenumber (kf) of Plate surface (Gaudard et al.). The side window buffeting is of the important application in this context. Present work will discuss the spectral decomposition in one and two dimensions. A Matlab code is used to post process pressure spectra to achieve better understanding of Cross power spectral density (CPSD). CPSD gives us variance of the in-phase and out-of-phase components of two time-series (quadrature spectrum). The phase information contained in CPSD estimates wave directional information. Ansys Fluent is used to generate time history data for the case of side window buffeting under influence of mirror. A scale resolving simulations like SBES is carried out to accurately account for smallest scale structures. An automated script is used to selectively generate time domain signal at well-defined array points. Another Matlab script is used to obtain cross spectral density and hence have wave number frequency spectra (WFS).

Presenter Name: Som, Probal

Presenter Company: Ansys India

Presentation Title: Reduced Order Model Based Sensitivity Assessment of Thermo-Mechanical Fatigue Life of Exhaust Manifold Subjected to Uncertainties in Material, Loading and Manufacturing (P. Som, Ansys India; Lvl: 3)

Type: Presentation

Keywords: Exhaust Manifold, Low Cycle fatigue, Thermo-Mechanical Fatigue, TMF, CTOD, DoE, Sensitivity Analysis, Meta-Model, Probability, Reduce order model, ROM, Manufacturing tolerance

Session Title: Reduced Order Modeling

Session #: 3-1

Room #: 26C

Abstract:

A need for higher efficiency in Power and Transportation sector is leading to increased range of temperature in several components like the cylinder head, exhaust manifold, turbocharger etc. Predicting low cycle fatigue failures, such as Thermo-Mechanical Fatigue (TMF), due to high thermal and mechanical loading is critical across the industry segments. TMF failure prediction requires accurate material characterization of relatively new materials like heat resistant alloys, which includes understanding the material behavior across temperature, strain rates, strain ranges and hold times. Also, for fatigue life estimation through simulations, traditional stress or strain based life calculation approaches can lead to false positives. Typically, an exhaust manifold undergoes fatigue, creep, oxidation etc. under high thermo-mechanical loading and accurate life prediction requires consideration of interplay between stress, strain and their orientations. A widely used simulation technique, which takes this into account, is the Crack Tip Opening Displacement (CTOD) based life prediction. This approach has been predominantly used by industries, but the predictability is often under question due to the uncertainties in inputs required for these calculations. These uncertainties vary from manufacturing tolerance, material variance, material curve fitting errors, loading variance and so on. The present study on an exhaust manifold attempts to take these uncertainties into account in a computationally effective manner. At the top level of the study, uncertainty in thickness distribution from casting process of manifold is addressed using a spectral decomposition based Reduced Order Modeling (ROM) technique. ROM based technique can quickly capture the randomness in thickness change coming out of casting process at different locations of the manifold geometry. It can update the nominal mesh to replicate any random thickness shape within the manufacturing tolerance. Finally, a variance based sensitivity analysis is performed including uncertainties in material modelling, loading and thickness distribution. Extracted meta-model of CTOD based life is used to identify the most important input parameters influencing the life. Further, parametric data from Design of Experiments (DOE) are used to calculate a non-exceedance probability measure for the possible fatigue crack locations and it enables the designers to have a definitive assessment of the crack locations against inputs uncertainties.

Presenter Name: Song, Nick

Presenter Company: Abbvie Inc.

Presentation Title: Modeling and Simulation Bring Deep Understandings of Medical Products to Improve Patient Experience (N. Song, Abbvie Inc.; Lvl:)

Type: Presentation

Keywords: FEA, modeling, simulation, medical device, life science, multiphysics

Session Title: Medical Devices 1

Session #: 2-2

Room #: 26B

Abstract:

Drug delivery devices and drug-device combination products involve complex working mechanisms, nonlinear materials with complex mechanical behaviors, and interactions between fluids and structures. The development and manufacturing of combination products entail deep understanding of the design, manufacturability, and reliability, where modeling and simulation offer unparalleled capabilities and complement testing based on physical prototypes. This presentation will provide a few case studies of device and combination products modeling at Abbvie. Bio-compatible polymers including thermoplastic polyurethane and thermoplastic elastomer are commonly used in medical devices such as drug delivery tubing and connectors. They provide excellent durability and resistance against oils and chemicals. Their mechanical properties are complex, exhibiting nonlinear large strain nonlinearity, hysteresis, and permanent set under cyclic loading. Hi-fidelity finite element modeling was utilized to study the performance of delivery system under various conditions. Results showed high margin of safety. Auto-injector is a combination of drug and device. A syringe pre-filled with drug is installed into a spring-loaded pen device to achieve automatic subcutaneous drug delivery. Finite element simulations of the firing/activation process provided deep insights about the working mechanism that were not known from prior experiments. Infusion pump is an electro-mechanical device used to deliver drug into human body at large volumes and over long period of time. Simulations showed working mechanism of the complex device that includes components made from nonlinear silicone rubber and thermoplastic polyurethane materials. Multiphysics modeling of auto-injector provided deep insights about the drug solution fluid flow driven by the device which were not easily measurable.

Presenter Name: Souza, Flavio

Presenter Company: MultiMechanics

Presentation Title: Modeling Failure in Fiber-Reinforced Composite Tubes (F. Souza, MultiMechanics; Lvl: 2)

Type: Presentation

Keywords: multiscale, failure, advanced composites, carbon fiber, defects, damage, microstructural, thermoplastic

Session Title: Advanced Composites

Session #: 1-1

Room #: 25A

Abstract:

Finite element analysis has become increasingly important for mechanical design and the development of new advanced materials. Being able to predict structural performance accurately and efficiently can circumvent the extensive time and cost of repetitive and rigorous material testing. However, with materials becoming more complex, the assumption of homogeneity as well as generalizing a material based on global properties does not sufficiently describe a structure close to failure. The key to accurately predict material failure is to realistically capture microstructural damage, but to capture this at a length scale orders of magnitude smaller than the full scale part is impossible with the drastic increase in computation time - it is not even possible to mesh it. In a wide variety of industries, unidirectional fiber reinforced composites are being utilized for high pressure containers and tubes, in which the high axial strength fibers can bear the majority of the hoop stress. To accurately predict the burst pressure of tubes, a finite element model must be able to incorporate defects from the composite manufacturing process, such as voids, resin pockets, variations in fiber volume fraction, and progressive damage. The challenge lies in modeling such microstructural features, which are at a length scale orders of magnitude smaller than the full product scale, as well as linking the microstructural models back to the product performance. For a thermoplastic unidirectional carbon fiber composite tube, MultiMech has demonstrated the ability to account for such microstructural mechanisms and process induced variation to more reliably predict the burst pressure and localized stresses within the composite. MultiMech utilizes a proprietary TRUE MultiscaleTM technology, a fully coupled two-way multiscale FE solver with the ability to accurately predict global structural failure based on microstructural design variables, without significant increase in computation time. For the thermoplastic composite tube, different defects such as voids and resin pockets were defined and stochastically inserted into the model to characterize a range of manufacturing variability. Because the defects are inserted randomly, multiple simulations can be run for each scenario to obtain a lower and upper limit of burst pressures for different tubes comprised of different types of defects and different percentages of defects. When compared to experimental evidence, the results demonstrate the robustness of the TRUE MultiscaleTM approach by its notably accurate predictions as well as speed in generating the results for such a nonlinear failure problem. This paper with demonstrate how MultiMech's TRUE MultiscaleTM technology can enable composite tube manufacturers to quickly and accurately predict product performance without the need to fabricate and test multiple physical prototypes, thus saving substantial amount of time and cost.

Presenter Name: Souza, Dustin

Presenter Company: e-Xstream Engineering LLC

Presentation Title: Multi-Scale Modeling of Additive Manufacturing: From Process Simulation to Design Validation (D. Souza, e-Xstream Engineering LLC; Lvl:)

Type: Presentation

Keywords: Additive Manufacturing, process simulation, polymer, composite, FDM, SLS

Session Title: Additive Manufacturing Process Analysis 1

Session #: 1-1

Room #: 25B

Abstract:

Additive Manufacturing of polymers is transitioning from rapid prototyping to a true industrial production technique. While it brings valuable opportunities to the industry, such as drastically decreasing the time-to-market of new products or enabling lightweight, multi-material and multi-functional designs, it also comes with a series of challenges for the engineers. The reliability of the mechanical properties of the final part still has some uncertainty and is not fully supported by standard engineering tools. Dimensional accuracy is not always met and cannot be predicted prior to printing. To cope with these issues, the engineering workflow which is daily applied for traditional manufacturing processes needs to be replicated and adapted to the Additive Manufacturing. Specifically, Additive Manufacturing of polymers and composites shows a very strong influence of the manufacturing on the material and global component behavior and its modeling constitutes a true multi-scale challenge. In this paper, multi-scale material modeling techniques – which are essential to handle the several scales involved in Additive Manufacturing – are presented and applied to 3D printing of polymers (unfilled and reinforced). Insights on how the process simulation of FDM/FFF or SLS method can be solved via coupled thermo-mechanical models are presented. The numerical simulation follows the real printing workflow, takes into account the process setup and the material behavior, allows to predict the deformed shape of the part and residual stresses and offers warpage compensation techniques. Industrial applications of process simulation are shown to demonstrate the validity of warpage predictions. Finally, a strongly coupled process-structure methodology is shown that predicts the as-printed mechanical behavior. This approach links the material anisotropy and the process-induced microstructure to the as-printed part performance and its validity is demonstrated against experimental tests. The part strength sensitivity to the printing direction is also highlighted in several applications. This integrative workflow, which accounts for the full manufacturing history of the part, enables the design validation and the optimization of the performance of AM designs.

Presenter Name: Souza, Clarissa

Presenter Company: Pontifical Catholic University of Rio de Janeiro

Presentation Title: Residual Stress Modeling in Arc Welding of Low Carbon Steel Joints: A Numerical and Experimental Investigation (C. Souza, Pontifical Catholic University of Rio de Janeiro; Lvl: 2)

Type: Presentation

Keywords: Thermal Stresses; GMAW; X- Ray Diffraction; Birth and Death Technique.

Session Title: Simulation of Manufacturing Methodologies & Processes: Welding

Session #: 1-3

Room #: 25C

Abstract:

Welding is one of the most used manufacturing processes in the industry, aiming mainly at the union of two or more components. The process adds versatility to the projects, optimizing them in what refers, among other factors, to cost and time. Due primarily to large temperature variations characteristic of the process, there are geometric distortions and residual stresses that can compromise the performance of a welded component. The quantification of these effects, as well as their minimization, has been the object of several studies with the purpose of improving the operational, economic, metallurgical and mechanical properties of the post-welding material. The use of the Finite Element Method as a tool for the thermo-structural modeling of the process has been the subject of several scientific researches. With this method it is possible to estimate thermal cycles resulting from welding by numerical representation of the heat source, as well as the estimation of the residual stress fields generated in the process. The thermo-mechanical study of the welding process by the Finite Element Method allows failures prevention, as well as improvements in the design. Different heat source models have been applied in order to more accurately describe the distribution of temperature in a welded joint. Goldak proposed a double ellipsoid model that is currently considered one of the best replicates experimental results. The parameters that determine the shape and size of the heat source can be easily changed in order to model their interaction with the material throughout the welding process. Once the thermal analysis is performed by the application of the heat source model, its results are used as loading in the structural analysis. It should be noted that for both analyzes, it is necessary to enter data on several parameters, such as voltage (V), current (I) and speed of the thermal source (mm/s), as well as temperature-convection curve, joint geometry and specimen geometry. This type of numerical approach has some restrictions. Some fundamental parameters, such as the cooling rate of the material, depend on experimental results. In addition, some more complex analysis require numerical simplification to make the study feasible. Therefore, although the numerical modeling of the welding processes is well established and there is a great evolution in the computational processing capacity, there is still a demand for new studies that, when integrating numerical and experimental analysis of real cases of engineering, contribute to the development of projects with greater efficiency and reliability. The present work presents a numerical and experimental investigation of residual stresses in welded joints of low carbon steel. AISI 1020 steel samples were butt welded by GMAW process with weld metal in a single pass. Experiments were conducted at different heat source speeds in order to evaluate the influence of this parameter on the level of residual stresses generated. Subsequently, the samples were subjected to measurement of residual stress by diffraction X-ray method. The numerical analysis was conducted in the ANSYS Finite Element software, in which the GMAW electric arc process was simulated with the application of a single pass in AISI 1020 steel plates joints. A good agreement between the experimental and numerical results was achieved. It can be concluded the proposed welding modeling process allows to predict the thermal distribution and residual stresses generated in the welding, contributing to the improvement of joint quality, cost reduction, and increased life and structural strength.

Presenter Name: Strain, Jeff

Presenter Company: Stress & Strain Technologies

Presentation Title: CAE Customization Options for Process Capture & Automation (J. Strain, Stress & Strain Technologies; Lvl: 2)

Type: Presentation

Keywords: customization, automation, scripting, journaling, finite element, simulation, programming, Python, API

Session Title: Simulation Governance: Process Management

Session #: 1-3

Room #: 24

Abstract:

As physics-based simulation continues to mature, customization and automation of simulation workflows are becoming increasingly vital components of the design and development process for experts and new users alike. Customization allows engineering organizations to streamline time-consuming, repetitive tasks and ensure consistent workflows that capture the overall expertise of the team. In doing so, potential for error and time to market are diminished, innovation is accelerated, more design options can be explored, and training time and costs for non-experts and new hires are minimized. Also, customization allows the organization to focus on the inputs and outputs of a problem rather than getting lost in the details. Customization usually involves some sort of scripting which may consist of general-purpose programming languages, APIs, and tool-specific command languages. We will explore the various options available along with the benefits and drawbacks of each such as ease of learning, breadth of capability, and flexibility. We will also discuss various methods of learning customization codes, particularly as they apply to non-programmers. These may include journaling, log files, templates, and reuse of existing scripts along with user manuals and web sites. Attendees will also be given recommendations on customization scripting strategies. These strategies include assessing how much should be scripted, what to start off with, and what to consider when improving the script to help the user avoid errors and implement more advanced routines. Automation can be a huge time and cost saver. However, automation may at times be met with certain drawbacks and pitfalls. There may also be instances where automation appears to be an appropriate strategy but turns out not to be. The presenter will examine these situations and provide some tips on when to automate and when to not automate, what to consider when deciding to automate tasks, and best practices for customization. At the end of the presentation, the attendees will be fully aware of the options available for CAE customization, how to gain fluency in these options, and how to strategize automation and customization.

Presenter Name: Stucker, Brent

Presenter Company: ANSYS

Presentation Title: Leveraging Thermal Simulations for Metal Additive Manufacturing Part Design & Qualification (B. Stucker, ANSYS; Lvl: 1)

Type: Presentation

Keywords: Additive Manufacturing, 3DSIM, Thermal Simulation, Microstructure Prediction, Distortion Prediction

Session Title: Additive Manufacturing Process Analysis 2

Session #: 1-2

Room #: 25B

Abstract:

Powder bed fusion based metal additive manufacturing (AM) processes form parts by successive melting and solidification of metal powder, scan vector by scan vector and layer by layer. Each AM machine manufacturer has developed unique scan strategies, resulting in machine-specific thermal histories in the parts produced on their equipment. In addition, when adding a new geometry into the build file processor software on a machine, the scan vectors that are produced can change based upon part location, orientation, and user parameter selections. As such, a single part design can have significantly different thermal histories depending upon what machine is used to build that part, what orientation the part is built in, and what parameters the user changes for that part. In order to accurately predict additive manufacturing process effects on a part, that part's unique thermal history should be taken into account. This requires consideration of machine-specific scan patterns. ANSYS/3DSIM can read in scan vectors from machine build file processors to enable this information to be considered in a simulation. Using machine/part specific scan vector information, detailed thermal histories can be predicted. That thermal history can then be used to predict thermally induced strains, distortion and stress, and their combined effects on part accuracy. The same thermal history can also be used to predict part microstructure and part properties based upon that microstructure. And that same thermal history can be post-processed to predict what different types of sensors would measure during fabrication of a part. This presentation will show an end-to-end simulation architecture for additive manufacturing based upon a combination of technologies. As part of this architecture, users can predict part thermal history, distortion, microstructure, sensor outputs, and properties. These predictions are useful for part design and qualification. An overview of these tools and validation of their predictions will be presented in this talk.

Presenter Name: Stupplebeen, Rob

Presenter Company: Optimal Device

Presentation Title: Giving Arthritis the Finger: Customized Medical Device, Optimized for Durability (R. Stupplebeen, Optimal Device; Lvl: 2)

Type: Presentation

Keywords: Medical Device, Customized Medicine, Arthritis, CT, MRI, DICOM, Simpleware, ScanIP, FEA, Finite Element Analysis, Abaqus, fatigue, fe-safe, Endurica, Rubber, Shape Optimization, Topology Optimization, Tosca, FDA, EMEA

Session Title: Medical Devices 1

Session #: 2-2

Room #: 26B

Abstract:

Rheumatoid arthritis is an autoimmune disorder that frequently affects the fingers and results in swollen and/or painful joints. Total joint replacement surgery is commonly required, in which a silicone elastomer prosthetic is implanted, to restore patient hand/finger function and alleviate pain. Design qualification requirements specify that the prosthetic must endure at least 10 million cycles in which the finger joint is flexed through 90 degrees, which is typically determined and verified through a battery of costly physical testing routines. However, physics-based simulation is becoming a commonly used method by medical device companies to enhance or replace physical testing, which can potentially save time and money when submitting for device approval to the US Food and Drug Administration (FDA) and the European Medicines Evaluation Agency (EMEA). The workflow presented here describes why and how to leverage patient-specific anatomical data, non-linear structural simulation, fatigue simulation and shape optimization to generate a customized simulation workflow to enhance device design of a total finger joint replacement. Standard treatment consists of removing the joint tissue and replacing with an off the shelf prosthetic. This workflow aims to customize both the implant and the excised joint tissue. The patient-specific CT scan data is provided by the open source Visible Korean project (Park et al. 2006). The Simpleware Software platform is used to import the image data of the hand, segment out the various tissue types by density, integrate the CAD geometry, from Catia, of the implant and generate the volumetric finite element mesh. With the geometric boundaries established for the tissues the implant is aligned with the anatomy and a boolean operation is performed to remove the tissue occupying the same space as the implant. In order to optimize the prosthetic and ensure compliance to the durability specification, a non-linear finite element model is created in Abaqus of the proposed treatment plan and of typical post-treatment duty cycle of the finger joint. Stress-strain behavior for the silicone elastomer is represented via a 3rd order Ogden hyperelastic law. Fatigue simulations are performed Durability calculations are made with Endurica's technology in fe-safe/rubber via Critical Plane Analysis to address the multiaxiality of loads experienced by the implant. Fracture mechanical behavior is defined via a non-crystallizing Thomas law. The calculation returns the number of duty cycle repeats required to grow a crack precursor from its naturally occurring initial size to its end-of-life size. Tosca is then used to both modify geometry of the tissue removal and the prosthetic shape with shape optimization. This entire workflow gives confidence of adequate durability and maximize patient outcome. Park et al. 2006. Visible Korean Human: Its Techniques and Applications. Clinical Anatomy 19:216–224

Presenter Name: Sullivan, Maria

Presenter Company: Adaptive Corporation

Presentation Title: One Ring to Rule Them All: Managing Simulation Projects across Multiple Tools and Software into One Efficient Solution (M. Sullivan, Adaptive Corporation; Lvl: 2)

Type: Presentation

Keywords: PLM, Simulation, Abaqus, workflow

Session Title: Simulation Governance: Data Management 3

Session #: 2-3

Room #: 24

Abstract:

The Product Lifecycle Management (PLM) world is barging into the life of simulation engineers and analysts promising higher efficiency. Countless software files and results, various tools leveraged for one project, sharing data among team members and data hand-off among disciplines. How can PLM be leveraged to manage it effectively and efficiently? What is it really all about? The answer is different for each and every company. Rarely does one size fit all when it comes to selecting and managing simulation processes, tools, data and results. At Adaptive Corporation, our expertise lies not only in PLM, but also understanding the simulation process and how it can vary amongst our clients of distinctive industries. We propose solutions tailored to our customers' specific needs, which may include different tools and software from various vendors, all in an effort to maximize each tool's strength to arrive at an optimal engineered solution. The purpose of this presentation is to demonstrate an efficient and effective simulation focused solution, leveraging the use of PLM. This includes creating and capturing CAD, simulation and process data, all which may be from different tools and software. We will follow a typical simulation workflow (CAD geometry, model preparation, FEA, fatigue calculation, optimization, report generation) while showing how to connect and streamline the data and develop re-usable and consistent processes. Our example will take CAD geometry created in CATIA, model preparation done in Abaqus/CAE and ANSA, analysis results from Abaqus, fe-Safe and TOSCA and leveraging ENOVIA as a PLM system. The tools used are merely examples here, as the data can come from any tool on the market. The ultimate goal is enabling the expert to spend more time working on engineering problems and less time hunting for data or trying to push data from one tool to another, which downstream translates to improved efficiency and cost-savings for product development.

Presenter Name: Sun, Zhaohui

Presenter Company: American Axle Manufacturing

Presentation Title: Efficient Simulation of Automotive Driveline System NVH (Z. Sun, American Axle Manufacturing; Lvl:)

Type: Presentation

Keywords: Noise, Vibration and Harshness, Parametric modeling, Standardization, Automation, Driveline

Session Title: NVH

Session #: 2-2

Room #: 26A

Abstract:

Efficient Simulation of Automotive Driveline System NVH Zhaohui Sun, Alexander Sandstrom, Tim Keer Noise, Vibration and Harshness (NVH) characteristics are critical in today's automobiles as consumers are expecting luxurious and comfortable driving experiences not only for passenger cars but also for trucks and SUVs. To effectively and efficiently achieve quiet automotive driveline systems by design, upfront CAE simulation becomes critical and essential. There are many challenges however to achieve this goal in the industry. As an example, for a major North American OEM truck program, there could be over a hundred driveline configurations. To conduct NVH analysis and design optimization on all the driveline configurations at early phase of the program, effective and efficient analytical tools and processes are required to be in place. The effectiveness of performing upfront analysis also relies on the model accuracy in predicting vehicle level performance before any physical test data being available. In this presentation, methodologies and processes used in performing automotive driveline system NVH analysis and design optimization studies at American Axle & Manufacturing, Inc. (AAM) will be illustrated and discussed. The typical challenges in efficiently and effectively simulating driveline systems are mainly addressed by - Standardization of data structure, label convention for FEA and CAD models. - Standardization of simulation processes using executable templates for global consistency and accuracy - Parametric modeling in CAD - Intensive usage of automation of pre- and post-processes using automation templates - Database enhancement and auto-updating An example of utilizing Comet Solutions Driveline Design SimAppTM is provided to illustrate the level of improvement regarding efficiency and consistency, based on an application of a major North American OEM truck program. Using the SimApps and underlying automation templates, we will demonstrate how even the junior engineers (non CAE experts) across the global organization are able to run these complex simulations consistently and accurately. The paper also discusses the needed future improvements and enhancements of these simulation products from the end user's perspective.

Presenter Name: Szarazi, Jerome

Presenter Company: Koneksys

Presentation Title: Integrating FEA Physics Models with System Engineering (J. Szarazi, Koneksys; Lvl: 2)

Type: Presentation

Keywords: system engineering, collaboration, systems simulation, requirement management, simulation data management, workflows, systems modelling standard

Session Title: Systems Simulation 1

Session #: 2-2

Room #: 26C

Abstract:

In order to promote traceability, consistency, interoperability and better collaboration between systems engineering and Finite Element Analysis (FEA)-based simulation activities, we propose a tool-independent description of FEA models that integrates with the Systems Modeling Language (SysML), for future standardization. As technical systems become more complex, it is important to support traceability between systems engineering artifacts such as requirements and test cases and corresponding FEA artifacts such as FEA models, simulation conditions and results. SysML is the standard for model-based systems engineering. It supports the description of system requirements, use cases, functions, structure, behavior and cross-cutting aspects. SysML can be formally extended through mechanisms for capturing additional domain-specific information. Modern FEA software provides a vast collection of library elements to simulate different physics at different level of abstraction. Model interoperability is essential for information exchange and traceability between requirements and simulation results. While there is a standard for model-based systems engineering in the form of SysML, there is no standard description of FEA models. Existing model descriptions are incomplete, tool-specific, informal or a combination of these. We presented this year at NAFEMS the first step toward formalization by describing finite element mathematics based on the topological characteristics that is formal and precise. In this work, we proposed to extend the finite element mathematics description with physics information to represent domain specific FEA library elements. The basis for this proposition is that many physics problems are described by the same mathematical structure and that variables and boundary conditions can be modelled independently from the physics. By composing these models with the finite element mathematics specification, domain independent FEA library elements can be created and then specialized to a specific physics with the corresponding units and variables. Domain independent FEA library elements help not only to connect but also to compose elements of different physics. On the system level, a topology model that is common to both physical system architecture and FEA library element models is used. As a result, simulation boundary conditions and system interfaces can be integrated leading to interconnected system components and simulations. With 1D simulation examples, using our own developed python code, integration benefits between FEA and SysML is described and also integration challenges discussed. We believe that the use of tool and domain independent descriptions will drive model interoperability and collaboration between domain specialists.

Presenter Name: Tan, Eugene

Presenter Company: AVL Advanced Simulation Technologies

Presentation Title: Frontloading Process in Powertrain Development - Virtual Design Release (E. Tan, AVL Advanced Simulation Technologies; Lvl: 1)

Type: Presentation

Keywords: Powertrain, frontload, validate, prototype, standardize, production, data, quality, method, model, workflow, benchmark

Session Title: Simulation Governance: Data Management 2

Session #: 2-2

Room #: 24

Abstract:

This presentation illustrates a powertrain development process based on a frontloaded approach that consists of comprehensive powertrain models and reliable simulation results validated by measurement. Together, these features allow prototype release based on a virtual powertrain. The frontloaded approach results in greater product maturity earlier in the development process and a smoother ramp down in resource requirements over time. Analysis and simulation is the cornerstone of any advanced development process. The foundation of the analysis and simulation process portrayed here is a knowledge base that forms the backbone of all CAE activities. This knowledge base is used in prototype and production development projects, and consists of standardized processes and methods as well as data and quality management. The key to this CAE management environment is a library of standardized methods. To date, there are over 180 analysis and simulation tasks (methods) in the knowledge base, as well as testing, calibration, design, reliability and statistics tasks. These tasks are required workflows for analysis and simulation teams worldwide. Each task comes with a general description, relationship to an assembly structure, lists of input and output, procedure checklist, detailed methodology and workflow, links to related projects, analysis/simulation models, reports, engines, and performance attributes and benchmarks. The standardized methods allow work to be shared easily and seamlessly among teams globally. The output is a similar, familiar product regardless of where the work is executed. This standardization also allows an apples-to-apples comparison of analysis/simulation results between different projects, where small differences in input parameters often make the output/results incomparable. Most importantly, this system of standardized methods forms the basis of a viable benchmark database of performance attributes. The featured knowledge base is built on a metadata model with multidimensional relationships between projects, assembly groups, standardized tasks, etc., where each can be cross referenced against the others. For example, given a standardized task, an analysis/simulation engineer can cross reference all assembly groups associated with this task as well as all projects that include this task. In the presented analysis/simulation-driven design process, performance attributes and targets are defined with regard to the development scope and project boundary conditions. These performance attributes are monitored throughout the development process for the entire product, assembly groups or subassembly groups. Problem areas (where performance attributes fail to achieve their respective targets) are highlighted and can be immediately addressed. According to the status of the performance attributes, a virtual design release can be made at a part or system level.

Presenter Name: Thomas, William

Presenter Company: TechnipFMC

Presentation Title: Optimizing Part Geometry with Constraints for Manufacturing (W. Thomas, TechnipFMC; Lvl:)

Type: Presentation

Keywords: optimization, oil and gas, FEA, CFD

Session Title: Optimization 3

Session #: 3-2

Room #: 26A

Abstract:

There are many optimization techniques documented in literature as well as commercially available as software. For parametric problems, optimizations methods include adjoint method, genetic algorithm, steepest descent, and Monte Carlo. For purely geometric optimization problems, topology optimization techniques can be employed. Once optimization is applied, non-intuitive geometries can result which improves the performance of the product. These optimized geometries can pose a challenge to traditional manufacturing as well as to new manufacturing technologies such as additive manufacturing. In this study, researchers have applied optimization to oil and gas production equipment and the resulting geometry were evaluated for manufacturing. The learnings from this study are captured so as to improve the constraints and objective functions used in the optimization routine. For this study, optimization techniques were applied to insulation, valves, seals, and flanges. Some of the learnings involve limits to the complexity of shapes that are manufacturable through AM. Other learnings include the limits of size for practical manufacturing. Finally the importance of tolerances on cost and performances are evaluated. The techniques in this study mainly focus on production equipment and commercially available software. The use of optimization techniques are evaluated for the net improvement in performance relative to increase in manufacturing cost. Also, the optimization techniques improvement on engineering execution is developed. Implementing optimization in your standard design workflow will cause a significant change for the better. Specifically, the collaboration between engineering and analysis departments are improved. Secondly, the optimization process requires that key information is determined from the outset including what is my objective function? What are my constraints? What are my design variables and their limits? When an optimization algorithm is launched, sometimes the results are unexpected. For those cases, one should not give up and go back to traditional techniques. Typically a constraint was missed when setting up the optimization causing an unexpected result. Despite the setback, the solution is straightforward - add the constraint and rerun the optimization. Optimization can straighten out the crooked and recirculating path of design.

Presenter Name: Tolle, Don

Presenter Company: CIMdata Inc

Presentation Title: Emerging Standards for Model-Based Systems Engineering (D. Tolle, CIMdata Inc; Lvl: 2)

Type: Presentation

Keywords: model-based, systems, standards, modeling languages, innovation, MBSE

Session Title: Emerging Standards

Session #: 2-1

Room #: 26C

Abstract:

Engineering organizations are experiencing a rapid increase in product complexity, driven by the need to continually innovate to survive and based on the exponential increase in the use of sophisticated electronics and software content in virtually every industry. The traditional "stage gate" methods of product development with separated "silos" of data, models and information across the engineering domains of mechanical, electrical/electronics, software, controls, chemical formulations, etc. is no longer adequate to define, optimize, assess and validate the performance of today's complex systems… and systems of systems. Collaborating virtually with globally distributed product development groups as well as suppliers and teaming partners is also becoming an increasingly critical aspect of the product development lifecycle for most industries. The risk of "business as usual" is now becoming well understood across all industries based on companies that have recently experienced systems level failures resulting in costly product recalls, warranty claims, and non-compliance with government regulations. These trends and other forces related to the rapid digitalization of all business processes and the movement towards Industry 4.0 have led to an increased focus on defining and adopting model-based processes and technologies for developing and maintaining complex systems, commonly referred to as Model-Based Systems Engineering (MBSE). Concurrent with the movement towards model-based approaches in the various engineering domains, industry has recognized and begun to address the need for more robust systems modeling languages and data interoperability standards. While systems modeling languages such as UML, MARTE and AADL and data interoperability standards such as the STEP AP2xx series have existed for some time now, the adoption rate has been limited to certain specialized domains and standards have had far less business impact than desired in the engineering domain as a whole. While still in the early stages of maturity, significant progress has been achieved just within the past several years based on emerging systems modeling languages such as OMG SysML and Modelica and data interoperability standards such as XML/XMI, FMI/FMU, ReqIF, MoSSEC and OSLC. In this session, we will provide an overview of the major engineering standards efforts underway and discuss the status of the most promising systems modeling languages and data interoperability standards, those that have the greatest potential to enable the collaboration required across engineering disciplines and support the achievement of the "digital thread" vision across the entire product development lifecycle.

Presenter Name: Topich, Jim

Presenter Company: Kinetic Vision

Presentation Title: Benefits of Industrial X-Ray and Computed Tomography (CT) Technology in the Advancement of Analysis and Simulation in Engineering (J. Topich, Kinetic Vision; Lvl: 1)

Type: Presentation

Keywords: modeling and simulation, engineering simulation, finite element analysis, industrial scanning, industrial CT scanning, 3D CT scanning, simulation validation

Session Title: Full Product Performance Lifecycle (PPL)

Session #: 2-3

Room #: 25A

Abstract:

Engineering simulation software, such as finite element analysis, have proven to be invaluable tools in the product development process. However, correlation between analytical results and real-world behavior can sometimes be poor. Production parts contain dimensional variations and material flaws that can be difficult to predict, and systems can have complex behaviors that are easily misunderstood or hard to replicate analytically. These discrepancies make it possible for technically accurate simulations to be poor predictors of real-world product performance. Industrial scanning, once used mainly for part metrology and inspection, is now advancing the use of engineering analysis and simulation tools by providing the means to create “as-manufactured” geometric models and conduct simulation test validations. This presentation will explain the basics of two main scanning methodologies, industrial x-ray and computed tomography (CT), and present how modeling and simulation engineers are leveraging scanning output data to validate their work, improve product quality, and shorten development times. Modern industrial scanning technologies are non-destructive and produce highly accurate three-dimensional geometric data. This allows for detailed understanding of internal and external features, material porosity, wall thickness variations, weld quality, component clearance/fit and a multitude of other issues affecting product quality that are difficult to externally visualize, measure or quantify. In addition to static experiments, time-varying 4D scanning enables the study of functioning products, mechanisms, fluids and moving particles. Actionable takeaways from this presentation will include: • Benefits, differences, and limitations of industrial scanning technology • Understanding of the types of experiments that can be completed using industrial x-ray and computed tomography (CT) • Varieties of data that can be created from the experiments • Presentation of relevant use-cases where industrial scanning technology is augmenting modeling and simulation efforts across multiple industries In conclusion, industrial scanning can be an extremely valuable tool to bridge the gap between purely analytical pre-production investigations and actual product field performance. The resulting data can be leveraged to improve and validate simulation models, giving the analyst greater insight and confidence in the analytical approach. Over time this feedback loop creates more robust and accurate predictive methodologies within the organization, shortening product development time and improving quality.

Presenter Name: Tummescheit, Hubertus

Presenter Company: Modelon

Presentation Title: FMI-Based Collaborative Workflows (H. Tummescheit, Modelon; Lvl: 1)

Type: Workshop

Keywords: FMI, Functional Mockup Interface, MBSE, Co-simulation, MBD, System Design

Session Title: FMI-Based Collaborative Workflows

Session #: 3-3

Room #: 22

Abstract:

The purpose of this workshop is to give an introduction to why the Functional Mock-Up Interface (FMI) is needed and how it can be used for collaborative model-based system development, analysis, and deployment. FMI reduces the barriers for coupling tools coming from different domains and thus enables left-shifting the virtual design effort for system design in true, analytic MBSE. The workshop will introduce the FMI standard and its specification including relevant use cases. Focus will be given to the issue of how to define model boundaries that will allow successful co-simulation. This will include guidelines and best practices for model decomposition. Numerical consequences and limits of performance for co-simulation of transient systems will be given and demonstrated with hands-on use cases. In addition, the workshop will be used to demonstrate system integration workflow automation and continuous engineering best practices for model based design. The upcoming System-Structure and Parameterization (SSP) standard, currently under development by the Modelica Association will also be presented briefly. The first public release of SSP is expected before the CAASE 18 conference. The current draft of SSP will be used in the workshop to capture the system structure, and system level parameterization in a standardized way. SSP is designed to be as a companion standard to FMI, but covers additional model formats beyond FMI. For this workshop, we will use the example of an industrially relevant use case and assume that the mechanical part, the actuation hydraulics, and the controls are modeled in three different tools and exported from each tool as a Functional Mockup Unit (FMU). For the workshop, all models are modeled in Modelica to allow evaluation of the differences between single tool simulation and co-simulation. This use case example will form the red thread of the workshop with export of the model from several FMI exporting tools and then integration of the exported FMUs into a systems model in an FMI integration tool. The system model will in turn be executed in several FMI importing tools. Lastly, use cases for automated testing and execution of the system will be demonstrated.

Presenter Name: Valachovic, Tim

Presenter Company: EASA Software

Presentation Title: Democratizing Engineering Models - Part 1 (T. Valachovic, EASA Software; Lvl: 1)

Type: Workshop

Keywords: democratization, model deployment, process automation, Excel, MATLAB, legacy code, R, PYTHON

Session Title: Democratizing Engineering Models - Part 1

Session #: 1-3

Room #: 23

Abstract:

While modern simulation and modeling tools have enabled huge leaps forward in engineering, the return on investment has sometimes been unnecessarily limited. Typical reasons include: 1. Legacy software is under-utilized. The evolution of software and hardware has had a dramatic impact on the way we interact with simulation tools, but this does not mean that the underlying physics and numerics of legacy programs, or MATLAB and Python scripts, are any less valid. In fact, these tools often encapsulate years of empirical observations, and have been thoroughly validated. 2. Many tools can only be used by experienced experts. Modeling and simulation software is typically not “democratized” – not in a form that lends itself to a large corporate user-base. If more engineers (and other functions such as technical sales staff) can be empowered to use modeling software, the benefit derived can grow significantly. 3. Excel chaos. Excel is used by countless engineers, either in support of modeling or for modeling itself. Too often, the value of well-developed spreadsheets is greatly limited because of the common problems such as lack of version control, poor IP protection, and unreliable execution due to mismatches in versions. Much greater value can be realized by transforming these spreadsheets into true collaborative design tools. 4. Inefficiencies in multi-step processes. Simulation and modeling often involves more than one piece of software. Integration and automation can significantly enhance the throughput, hence the value, particularly for a frequently repeated design process. During the hands-on workshop, attendees will use EASA, hosted on Amazon Web Services, to complete one or more of following tasks: 1. Transform a simple spreadsheet used for engineering calculations into a collaborative web app; 2. Build a fit-for-purpose web app and connect it to a MATLAB model; 3. Take a legacy structural analysis program with text file input, and modernize it with an intuitive web-based GUI. Note: EASA is a low-code development platform. This type of technology, also known as “hpaPaaS” – High Productivity Application Platform as a Service – enables “citizen developers” or “authors” to “appify” and democratize “expert-only” software tools and models. It enables non-programmers to codelessly create custom, fit-for-purpose apps, complete with error trapping and design or business rules embedded.

Presenter Name: Vasu, Anoop

Presenter Company: American Axle Manufacturing

Presentation Title: Quantifying Model Form Uncertainty in Welding Life Prediction Models Using Bayesian Framework for Axle Components (A. Vasu, American Axle Manufacturing; Lvl:)

Type: Presentation

Keywords: Weld Life Prediction; Structural Stress Method; Model Form Uncertainty

Session Title: Contact, Joints, Welds & Connections 2

Session #: 1-2

Room #: 25C

Abstract:

When multiple numerical physics-based simulation models exist to predict the responses of an engineering problem, it becomes difficult to choose the best approximating model. This is because none of the models can represent the physical behavior completely. It is beyond our ability to select the best approximating model based on a particular set of test data since additional data might result in supporting another model better than the initial one. This uncertainty, called the model form uncertainty, if ignored can lead to erroneous predictions of the engineering problem. This approach incorporating model form uncertainty can be very useful for weld life prediction where the simulation models are significantly different from each other. In this paper, four widely popular approaches for weld life prediction is utilized for quantifying the model form uncertainty. They are nominal stress method, hot-spot stress method, notch-stress method, and traction structural stress method respectively. The nominal stress based weld classification method is the simplest and most commonly used weld life prediction method. The local stresses at the weld toe need not be calculated in this method. However, the nominal stress parameter for many welded structures maybe inadequate and not available. In hot spot stress, the increase in stress due to overall joint geometry is captured by an extrapolation of geometric stress distribution to the weld toe location and has been commonly applied to tubular structures. The notch stress method assumes an effective notch root radius at the toe and the fatigue assessment is performed by a fatigue resistance SN curve. All these aforementioned methods has produced consistent results in various applications. However, the consistency in determination of stress, the effectiveness of SN data correlation, and the robustness in prediction are often questioned. The mesh-insensitive traction structural stress method addresses these issues and have been proven valuable to the weld life prediction of automotive axle components. In this paper, model averaging using Bayesian statistics is used to combine the model prediction to obtain a unified system response. Benchmark test data involving multiple load cases will be used to illustrate the implementation of the proposed technique. The process will be extended to the determination of confidence band for brake flange weld failure on a full beam axle.

Presenter Name: Wagner, Robert

Presenter Company: NASA Langley Research Center

Presentation Title: NASA Langley Pendulum Swing-Drop Dynamic System (R. Wagner, NASA Langley Research Center; Lvl: 1)

Type: Presentation

Keywords: Pendulum, dynamic system, nonlinear oscillation, swing-drop

Session Title: Multibody Simulation 1

Session #: 3-2

Room #: 26C

Abstract:

NASA Langley Pendulum Swing-Drop Dynamic System Yingyong Li and Shih-Yung Lin NASA Langley Research Center, Hampton, VA, 23681 U.S.A Robert L. Wagner Northrop Grumman, Hampton, VA 23681 U.S.A. NASA is investigating the potential of water landings as astronauts return to Earth in the new Orion Multi-Purpose Crew Vehicle (MPCV). The Orion MPCV is an American spacecraft intended to carry a crew of four astronauts to destinations at or beyond low Earth orbit (LEO). To aid in the understanding of the impact dynamics of such a landing, the NASA Langley Research Center has embarked on a test campaign using a water filled basin and a pendulum system to provide the required velocities and orientations to the MPCV. The pendulum system, and its dynamics, having a long and interesting history, attract scientific investigations and make various applications from clock mechanisms to the modern study of chaotic phenomenon. The pendulum swing-drop dynamic system at NASA Langley not only involves its typical dynamic characteristics but also must provide the desired performance, such as, impact velocity vector and impact pitch and roll angles. To accomplish this, an Integration Platform (IP) was designed that provides the interface between the MPCV test article and the Langley Landing and Impact Research Facility's winch cable suspension system that oscillates like a pendulum. The IP assembly was designed and analyzed for nonlinear oscillations of the test article with various considerations, such as, mass distribution, center of gravity locations, swing hardware, and cable tension. Analysis results from dynamic simulation will be presented and compared to test. Updates to the analytical model to improve test / analysis correlation will also be described. KEYWORDS: Pendulum, dynamic system, nonlinear oscillation, swing-drop, Langley Landing and Impact Research Facility, winch cable suspension system, Integration Platform assembly, dynamic simulation, test / analysis correlation, impact dynamics, gravity, cable tension

Presenter Name: Walsh, Joe

Presenter Company: intrinSIM LLC

Presentation Title: ASSESS Initiative: Collaborating with NAFEMS to Enable the Simulation Revolution (J. Walsh, intrinSIM LLC; Lvl: 1)

Type: Workshop

Keywords: Business, Generative, Systems, Credibility, Democratization, Generative, Revolution

Session Title: ASSESS Initiative: Collaborating with NAFEMS to Enable the Simulation Revolution

Session #: 1-3

Room #: 22

Abstract:

These Workshop will outline the need for a Simulation Revolution and how NAFEMS and the ASSESS Initiative are collaborating to Enable a significant increase in usage and benefit of Engineering Simulation software. The following topics will be discussed: • The need for a Simulation Revolution • ASSESS Initiative Background • ASSESS / NAFEMS Collaboration • ASSESS Theme related update & plans o Alignment of Commercial, Research and Government Efforts (Align) o Business Challenges (Business) o Democratization of Engineering Simulation (DoES) o Engineering Simulation Credibility (Credibility) o Generative Design (Generative) o Integration of Systems and Detailed Sub-System Simulations (Systems) • ASSESS Initiative Membership Program • ASSESS 2018 Congress This could be 1 or 2 Workshop sessions. If it is a single workshop we can focus on highlights of each area. Making this 2 workshop sessions would allow for diving deeper into each of the ASSESS Themes and how they dovetail into NAFEMS activities and CAASE18 themes along with an opportunity for an extended Q&A. The changing role of Engineering Simulation* is really about business benefits. However, achieving those benefits and associated growth of the Engineering Simulation market is tempered due to the lack of expertise available. A simulation revolution needs to occur bring a whole new set of opportunities and challenges. The ASSESS Initiative is a broad reaching multi-industry initiative with a primary goal to facilitate a revolution of enablement that will vastly increase the availability and utility of Engineering Simulation, leading to significantly increased usage and business benefits across the full spectrum of industries, applications and users. The vision of the ASSESS Initiative is to bring together key players for guiding and influencing the software tool strategies for performing model-based analysis, simulation, and systems engineering. To achieve this vision the ASSESS Initiative will collaborate with multiple activities and organizations across the complete spectrum of Engineering Simulation. Business drivers are forcing a "simulation revolution" to overcome the expertise based limitations which are restricting the expansion of Engineering Simulation applications. Increase Innovation Increase Performance Improve Quality/Risk Management Reduce Time Reduce Cost Engineering Simulation is a major key to all 5 business drivers in providing better understanding of product and process behavior, variability and risk.

Presenter Name: Wang, Jin

Presenter Company: ANSYS Inc.

Presentation Title: Tire Performance Simulation (J. Wang, ANSYS Inc.; Lvl: 2)

Type: Presentation

Keywords: ANSYS,Tire,FEA,Steady State Rolling,Cornering,ALE,Map2dto3d,Mesh Independent Rebar,

Session Title: Structural Analysis 1

Session #: 1-1

Room #: 26B

Abstract:

Finite element analysis (FEA) of tires is the established process followed by tire companies to improve the performance of tires during design phase and reduce the design cycle time as well. ANSYS has developed a few new features recently which can be used to perform FEA of a tire in different loading conditions like inflation, footprint, steady state rolling, cornering, etc. In general, the tire is a complex composite structure which is made of material like rubber (modelled as hyperelastic material) and reinforced structure material (like steel cords which are modelled as linear elastic material). In this work, a tire performance simulation is performed on a realistic radial tire model using ANSYS software. A 2D axisymmetric tire model is considered here with axisymmetric tread pattern. Axisymmetric elements with torsion degree of freedom (PLANE182) are used to model it. Reinforcement elements are created at bodyply and belts regions. The modelling of the reinforcing layer in ANSYS software is now easy with the newly developed “mesh independent” rebar creation method. In the first couple of analyses, the tire is mounted on the rim and inflation analysis is performed. Then, with the help of new “Map2dto3d” technology in ANSYS, the 2D axisymmetric tire model is converted to full 3D model (including results) and analysis is continued on the full 3D model for footprint and steady state rolling analyses. The steady state rolling of the tire is performed using an arbitrary Lagrangian Eulerian (ALE) formulation, which was recently implemented in ANSYS. For a given vehicle speed, different operating conditions (braking, traction and free rolling) between the tire and road are investigated. A few cornering analyses are performed on the tire model at a free rolling condition and cornering forces are computed for different values of camber angle. The effect of camber angle on footprint results and cornering forces are also computed and investigated. This paper also shows how the full tire performance simulation can be easily performed in ANSYS Workbench Mechanical with the use of the newly created ACT app specially created for tire analysis. This new app helps set up the tire model in more user friendly manner. It also allows user to perform Map2dto3d and further 3D analyses (like footprint, steady state rolling etc.) in the Workbench Mechanical environment. Authors names: Deepak Hasani Jin Wang

Presenter Name: Wang, Annie

Presenter Company: Senvol

Presentation Title: Applying Machine Learning to Additive Manufacturing to Analyze the Relationships between Manufacturing Process and Material Performance (A. Wang, Senvol; Lvl: 2)

Type: Presentation

Keywords: Additive Manufacturing, 3D Printing, Machine Learning, Algorithm, Material Properties, In-Situ Monitoring

Session Title: Additive Manufacturing Process Analysis 2

Session #: 1-2

Room #: 25B

Abstract:

This presentation showcases an ongoing STTR project funded by the Navy. The technology that is being developed in this STTR is a data-driven machine learning algorithm with key capabilities that will enable a user to reduce the time, cost and resources required to characterize additive manufacturing (AM) materials and AM processes for metal parts. The algorithm being developed is material, machine and process agnostic. Moreover, the algorithm would “learn” from previous data sets and apply those learnings to new data sets, thereby decreasing the amount of data needed in the future. The Navy intends to use this algorithm to assist in developing statistically substantiated material properties in hopes of reducing conventional material characterization and testing that is needed to develop design allowables. As additive manufacturing (AM) is increasingly being used to manufacture end use parts, AM users are keen to have tools that assist the design and manufacturing process. Generally, AM users are looking to answer two questions: (1) given a target mechanical performance, what AM manufacturing “recipe” should I use, and (2) given an AM manufacturing “recipe,” what mechanical performance should I expect. In attempting to reduce the high cost of material characterization, process qualification, machine qualification, and part certification through traditional means (e.g., developing large empirical data sets for design allowables), AM users have turned to model and simulate the AM process to help answer these two questions. Currently, almost all modeling approaches being applied to AM are physics-based, which are challenging to verify and validate and computationally expensive. We are taking a different approach, which is to develop a data-driven machine learning algorithm. Machine learning is a powerful tool that has been used in a wide variety of industries and applications but has not yet been applied to AM. Specifically, machine learning is able to offer capabilities that are of great interest to AM users, such as the ability to “learn” from one data set and apply those learnings to a new data set, which would decrease the amount of empirical data that needs to be collected over time for an AM user. A data-driven machine learning algorithm is focused on analyzing correlations (not causation) and thus can be applied to any AM machine, material, or process, making it totally agnostic and ideally suited for AM users. Overall, this presentation will outline our approach for using machine learning to investigate the relationships between process parameters, process signatures, material properties, and mechanical performance of metallic components. We will discuss why a data-driven machine learning algorithm was employed over other modeling approaches along with its advantages and disadvantages. We will also discuss some of the data that we have collected and demonstrate some of the algorithm’s capabilities. The presenter is Annie Wang, President of Senvol, who is the Principal Investigator of the STTR.

Presenter Name: Wang, Cong

Presenter Company: General Motors Corporation

Presentation Title: Modularization of FEA Models as Key Enabler for Simulation Data Management (C. Wang, General Motors Corporation; Lvl: 3)

Type: Presentation

Keywords: Simulation Data Management, CAE model modularization, Enabler for CAE leading design

Session Title: Simulation Governance: Data Management 1

Session #: 2-1

Room #: 24

Abstract:

At leading automotive OEMs, CAE community have been stepping up to face the increased challenges: • More stringent vehicle mass/performance targets and packaging requirements • Further emphasis on up-front CAE synthesis to lead the vehicle development • Proliferation of vehicle variants and loadcases with reduced development time • Increased bandwidth for sharing vehicle architectural and commodity parts • Global execution and work sharing At GM, CAE is increasingly called upon to • Make early assessment/synthesis and deliver actionable insight in the form of proposals/counter measures for product innovation • Balance and manage requirements/targets and their flow down • Leverage and execute through effective global engineering work sharing among full-functional engineering centers at numerous regions (i.e., not just one mega engineering center supported by satellite groups) To help meet the challenges, GM CAE is on a journey for value-driven Simulation Data Management (SDM) implementation as part of its CAE strategy. When taking a general look at how SDM has been planned or implemented at various companies/institutes in different industries, we have observed the plans/implementations at many large OEMs and cast in various themes have explicitly or implicitly the following common assumptions: • Need a comprehensive and high fidelity design “freeze” as starting point • Perform CAE assessment/review mainly in discovery mode of the tracked design • Most CAE objects remain in the native format of individual CAE apps and many are constructed at relatively high granularity mapped to on-going design but without internal modularization In essence, CAE’s effort is mainly focused on performance statusing of the on-going design at current gate/milestone and suggest remediation to be addressed by next gate/milestone. In this context, SDM can indeed help tracking and bringing together CAE objects with proper pedigree. In reality, we know that (the “..” in the bullets below is left for imagination): • Design never freezes except for … • Synched PDM/CAD data are not necessarily complete and mature except for … • Each key review gate needs to be a decision (not discovery) gate based on most upto date design status and proposals (which may not have gone through a synched PDM/CAD release) • SDM’s value will be limited if CAE objects are still trapped in siloed apps and granularity not aligned not aligned with CAE proposal development At GM, we view the SDM implementation from the perspective that it is a decision support function meant for leading the design, but not part of the digital product design & release process itself. This requires further comprehending the traits and needs of assembling and managing CAE models as compared to PDM/CAD. We see the need for a modular approach to reconsider how CAE models and objects should be built and assembled that would promote much improved inter-operability, rapid decompose, re-content, and re-assembly, not just for a given model, but also for a family of relevant models. Enablers coming out of the modularization effort are expected to facilitate: • Model content management of ‘surrogates/abstracts/functional’ from other sources as well as from PDM/CAD • Subsystem and components model/module re-use • CAE proposal development and rapid and systematic model updating • Management of CAE proposals This paper will discuss the development of such enablers and their applications.

Presenter Name: Wang, Gary

Presenter Company: Empower Operations Corp

Presentation Title: Data Driven Design Optimization and Application Based on Small Sampling Learning (G. Wang, Empower Operations Corp; Lvl: 1)

Type: Presentation

Keywords: intelligent engineering design, data-driven design, machine learning, design optimization

Session Title: Optimization 2

Session #: 3-1

Room #: 26A

Abstract:

Despite continued progress, simulation-based design optimization still requires lots of iterative simulation calls. Modern simulation models are “invisible” as their function structure is hidden from the users and thus considered black-boxes. They are also computationally expensive and lengthy. Under this context, how to use the smallest number of simulation calls to get to the optimum? New generation of optimization methods use small samples to deal with this challenge. The goal is to learn from the limited data to achieve the highest efficiency in looking for the best design possible. This talk will introduce some of the recent technologies from Empower Operations Corp. and its applications to real-world challenges. Derived from the field of metamodel-based design optimization, our methods show clear resemblance to the machine learning methods. This talk will introduce Trust Region-based Mode Pursuing Sampling (TR-MPS) method, and the Optimization on Metamodel-supported Iterative Decomposition (OMID) method. These methods have been successfully applied to a General Motor assembly process planning problem. In this project, the goal is to automatically optimize the locators’ positions for the auto body assembly. A third-party commercial dimensional analysis software tool, referred to as “Software D” to conceal its actual name, is used to simulate the assembly process. The final assembly quality measures are obtained from Software D for different configurations of the locators during the optimization process. During the optimization process, the algorithm iteratively nominates new sets of locator configurations that are subsequently simulated in Software D. The overall assembly variation (i.e. the optimization objective function) is then returned to the optimizer, which suggests new configurations (design variable values). In the context of simulation-based design, usually a problem with more than ten dimensions (d>10) is considered as a high-dimensional problem. On the other hand, the objective function (i.e., variances at key product characteristic points on the final assembly) of the optimization problem is calculated via Monte-Carlo simulation in Software D. This makes the optimization problem computationally expensive, which is often considered as an expensive black-box. Thus, in this project, the optimization involves High-dimensional, Expensive, and Black-box (HEB) functions, which is very challenging from both theoretical and practical perspectives. Moreover, the parts often have complex geometries with curved edges and three dimensional features. Therefore, it is difficult to define the possible position of locators as a continuous planar space. To overcome this difficulty, a discrete set of feasible locations is defined for each part. Therefore, the combination of locations of entities (on each part) defines the search space. This means the problem is combinatorial in nature, which makes it even more difficult to optimize. The total number of possible solutions reaches to the order of 10 to the power of 172. Furthermore, it is also found that since the objective function involves the variances at more than 200 key product characteristic (KPC) points, the optimization is essentially a multi-objective problem. By summing all the objectives into one function, the problem is turned into a single-objective but multimodal function. It is found that the objective function has many local optima and is a “choppy” function, which increases the difficulty for optimization. In summary, this problem is HEB, combinatorial, and multimodal, which represents a world-class difficult problem to solve. Using our approach, the assembly quality has been improved by 65% with only 10,000 sample points. Some other interesting things have been learned as well from the project.

Presenter Name: Warning, Alexander

Presenter Company: Pepsi Co

Presentation Title: Simulation Guided Packaging Designs for a Flavor Delivery System (A. Warning, Pepsi Co; Lvl: 2)

Type: Presentation

Keywords: CFD, FEA, multiphase, design

Session Title: Multiphysics 3

Session #: 3-2

Room #: 21

Abstract:

Packaging design is an important aspect of a new flavor delivery system that critically impacts the customer experience of a consumer beverage product. To optimize the packaging design and enhance customer experience, various simulation tools were used in this study to gain physical insights of the product consumption process and speed up the packaging design cycle. The flavor delivery system consists of a pod of liquid and powder separated by a thin film. The consumer will put the pod in a special designed bottle with fixture to host the pod, flips the cover to crack open the pod and thus makes the drink. In the cracking open process, the fixture tears the film in the pod to release the powder and evacuate the liquid on top washing away any remaining powder. There are two major design challenges with this delivery system. One is that the flavor containing powder needs to be fully evacuated in the cracking open process. Depending on how the pod cracks open and tears the film, significant amounts of liquid and/or powder can remain in the pod which is undesirable to a consumer. The second challenge is that the cracking open force of the pod needs to be consistently low while maintaining mechanical integrity. The two challenges needs to be solved simultaneously since the mechanical design characteristics determine how the pod/film cracks open which in turn affect how powder is being evacuated by the draining fluid. A multiphase Computational Fluid Dynamics (CFD) model was used to understand and optimize the packaging design to maximize powder evacuation from the pod. The model geometry was obtained from a CT scan of cracked open pod, including the torn plastic film. The cap teeth design, fluid-solid interaction, and powder particle properties were studied to understand how they affect the powder evacuation in terms of how much was left over and how quickly it took for all fluid to leave. The model was able to show where problematic regions in the different pod designs exist in terms of liquid pooling and thus not evacuating, and regions where the liquid velocity was too low to carry away particles into the water bottle. The model was also used to vary the pod surface hydrophobicity to understand pod leakage and what the critical contact angle was for different designs.

Presenter Name: Weinberg, David

Presenter Company: Autodesk Inc.

Presentation Title: Generative Design of Lightweight Lattice Structures with Additive Manufacturing Constraints (D. Weinberg, Autodesk Inc.; Lvl: 2)

Type: Presentation

Keywords: nastran, topology optimization, RVEs, lattice structures, additive manufacturing constraints, 3D printing

Session Title: Product Design Based on Additive Manufacturing 2

Session #: 2-2

Room #: 25B

Abstract:

For the past three decades, topology optimization has been remarkably popular in the engineering design community due to its capability on designing lightweight structures by optimally distributing materials to carry loads. Recent research trends in topology optimization include multidisciplinary optimization, hierarchical distributed computing, and various manufacturing method-oriented design. In particular, generating lightweight designs that can be producible by various manufacturing methods is critically important in industry. These include various manufacturing methods, such as minimum/maximum member size, various symmetry, extrusion, casting, milling, and 3D printing. In particular, 3D printing, or additive manufacturing, becomes an emerging technology as it allows manufacturing complex shapes that were not possible in conventional subtractive manufacturing technologies, such as milling. The current research trend in topology optimization for additive manufacturing focuses on how to design a structure so that the amount of supporting materials can be reduced or removed. However, the technology still remains in the regime of producing solid, isotropic materials. Due to remarkable advances in the additive manufacturing technology, it is now possible to build lattice structures, which involve repetitive patterns of a particular cell shape or type. In fact, lattice structures can be a unique feature for additive manufacturing. It has been demonstrated that lattice structures can reduce the structural weight with the same functionality as with homogeneous materials. Conventional topology optimization is too restrictive since it cannot create intricate microstructures as provided by a lattice solution. The objective of this work is to seamlessly integrate the concept of lattice structure with topology optimization. First, 16 different shapes/patterns of lattice structures are modeled using representative volume elements (RVEs). The behavior of a lattice structure is homogenized using an anisotropic material. This is a similar concept used in composite materials and multiscale modeling. The stiffness of a lattice structure is a function of the diameter of beams that composed of the lattice structure. The volume fraction of lattice structure can be changed as the diameter of beams changes. Since the volume fraction changes during topology optimization, it would be important to make a relationship between the volume fraction and the stiffness of a lattice structure. We utilize a polynomial response surfaces for this relationship. Two possible integration strategies will be discussed. The first strategy is to replace the void region in topology optimization with lattice structures, while the second is to replace the solid region to lattice structures.

Presenter Name: Westwater, Gregory

Presenter Company: Fisher Controls International LLC

Presentation Title: Influence of Numerical Contact Formulation on Simulation of Natural Frequency (G. Westwater, Fisher Controls International LLC; Lvl: 2)

Type: Presentation

Keywords: Contact Formulation, Modal Analysis, Natural Frequency, Contact Stiffness

Session Title: Contact, Joints, Welds & Connections 1

Session #: 1-1

Room #: 25C

Abstract:

When linear perturbation methods are used to determine the natural frequency of a preloaded assembly, it must be recognized that numerical methods inherent to contact formulations can impact the stiffness matrix that is passed to the modal solver. Contact settings that are ideal for convergence of stress analyses may not always lead to accurate prediction of natural frequency. For example, default software settings can lead to contact stiffness values greater than that of the base material, typically causing the resulting natural frequency to be overestimated. Prior published research will be referenced to illustrate that tuning the contact stiffness is an accepted approach that can be used to improve accuracy. In addition to directly managing the contact stiffness to values which are physically appropriate, tuning can also represent physical effects of surface finish, microslip, and so forth that cannot be practically modeled. Capturing such effects at contact interfaces is one reason why it is important to include test fixtures and a portion of the ground reference instead of assuming a fixed support. Users of tuned models must consider that modifications in proprietary algorithms may change the accuracy of their results as commercial codes evolve over time, or that re-tuning may be required when changing software. Likewise, factors such as element size or material properties may be inputs to proprietary formulations that limit scalability of tuned methods across different simulations. Examples of simulations on slender beam and frame structures with welded joints will be compared to published test results. Simulation work from an industrial control valve actuator with bolted joints will also be presented with corresponding lab test data. The work presented will illustrate the sensitivity of the results to how and where the boundary conditions are imposed as well as how selection of different contact settings and mesh sizes influences the predicted natural frequencies.

Presenter Name: Wilkes, Chris

Presenter Company: Sigmetrix

Presentation Title: Tolerance Analysis - An Engineering Simulation of Production and Performance Quality (C. Wilkes, Sigmetrix; Lvl:)

Type: Presentation

Keywords: tolerance analysis, simulation, MBD, model-based definition, GD&T

Session Title: Simulation of Manufacturing Methodologies & Processes 2

Session #: 3-2

Room #: 25B

Abstract:

Tolerance analysis is too often considered an afterthought performed just before, or sometimes even after, a product has moved from the design phase into production. In a survey of over 100 companies 47% indicated that they perform some tolerance analysis studies but don't do enough, while another 31% felt confident that they had good coverage for critical functional requirements but still experienced downstream problems related to tolerance analysis. Several software tools capable of analyzing complex problems have been on the market for decades, but historically they have been complex to use and required the development of specialists focusing on such analyses. In recent years, though, some tools have been focusing on improving ease of use making them more accessible to a greater number of engineers. Industry adoption of Model-Based Definition, or MBD, and Model-Based Enterprise (MBE) has also made the important tolerance analysis information available in the part models and therefore accessible by tolerance analysis software, making the work required to complete the tolerance analysis studies easier and faster than ever. This presentation will demonstrate the application of modern tolerance analysis software to a simple example problem and compare the process to traditional tools such as spreadsheets. It will also demonstrate how the software can be used during design to make improvements as efficiently as possible and during production to make several different types of business decisions including vendor selection, use/scrap decisions for non-compliant parts, and where best to spend money on data collection. Objectives: • Realize the capabilities of modern tolerance analysis software to update the part specifications in real time driven by the tolerance analysis results • Recognize that many apparently simple stackup analyses are often more complex than expected • Review benefits of tolerance analysis software over spreadsheets • Learn benefits of tolerance analysis software during production

Presenter Name: Wu, Jianhai

Presenter Company: Shanghai Zhongli Investment Co., Ltd.

Presentation Title: Implementing the Democratization of Simulation at Zhongli (US & China) – The Goals, Challenges and Successes (J. Wu, Shanghai Zhongli Investment Co., Ltd.; Lvl:)

Type: Presentation

Keywords: Democratization of Simulation, Simulation Governance, Simulation Driven Design, SPDM, Simulation Automation, CAD/CAE Integration, Non-Experts Accessing Simulation

Session Title: Democratization 2

Session #: 1-2

Room #: 23

Abstract:

Zhongli is a global group that manufactures most of the super elastomer automotive parts including shock absorbers, engine mounts, and chassis components, with departments covering R&D, design, manufacturing, and sales and integration. Over the years, Zhongli has accumulated expertise in CAE analysis specifications for their products. These CAE best practices generate acceptable, validated solutions to all kinds of simulation problems related to their product families, providing accurate analysis results and reliable suggestions for design engineers, which greatly reduces the design cost while increasing the quality. With the continuous expansion of the business, the company depends on the expert CAE engineers to perform more and more analysis, resulting in these CAE experts becoming bottlenecks in the product development process. The need for expert CAE resources continues to grow and it is expensive and difficult to find. Due to the low efficiency of the analysis processes (most of the work is done manually by the experts each time), the design cycle has increased. This sometimes leads to the loss of customers and lower quality designs, greatly affecting the core competitiveness of the company's products. The Comet Workspace is a highly integrated CAE platform that has enabled Zhongli's CAE experts to easily capture their best practices in reusable simulation templates which can be used as a reliable, repeatable analysis process. CAD engineers can also use these analysis templates to perform complex simulations as part of their product design process, without the need to depend on the experts to perform all the simulations. The non-expert CAD engineers are able to get reliable simulation results rapidly, resulting in a reduced design cycle, higher quality designs and lower costs. Using Comet templates, the simulation processes for strength, modal and stiffness of most Zhongli products which include chassis shock absorber parts, chassis bushings and suspension components have been automated successfully for use by both the CAE experts and the CAD engineers (the non-experts). While the templates are easy-to-use, the accuracy of the calculations meet the high CAE standards of the company. Zhongli engineers estimate that the use of Comet SimApps for performing the company's standard product simulations now covers 40% of all simulations. As the ROI has been quite high, they are now working on developing SimApps to cover the remaining 60%. In this presentation, we will describe the SimApps that were developed and how they are used, the challenges in developing the templates, and the return-on-investment that has been achieved by using these simulation templates in the product development process.

Presenter Name: Xie, Jianhui

Presenter Company: ANSYS

Presentation Title: Simulation Solver Meshing in Graph Representation (J. Xie, ANSYS; Lvl: 3)

Type: Presentation

Keywords: FEA, Solver-meshing, Simulation, AI and Deep Learning

Session Title: Advanced Information Technologies

Session #: 3-3

Room #: 25A

Abstract:

An innovative graph-based generic FEA remeshing framework is introduced in this paper, which treats an FEA unstructured mesh and high-level mesh entities as special graphs, which serves as an ideal bridge to apply AI and machine learning in the solver-mesh data flow needed in CAE simulations. Recognizing that FEA meshing is an NP-hard problem (nondeterministic polynomial time), modern FEA unstructured mesh technology always includes heuristic algorithms which makes meshing a natural process for using data based AI and machine learning to automatically explore and achieve better mesh quality to match an FEA solver's on-the-fly needs. This paper also introduces the next generation CAE solver-mesh concepts as following: (a) AI/machine learning is coming for the next generation of CAE, and meshing is naturally a special kind of graph which makes it a good candidate as a pioneering application in CAE; (b) meshing/remeshing has a strong trend being in the entire engineering simulation life time including preprocessing, solving, post-processing, and even geometry reconstruction; (c) a PDE is not only used to solve physical fields, but also gracefully used in the meshing process to generate/modify mesh (nodes/elements) itself. Modern machine learning and data flow libraries (e.g., Google's TensorFlow) tend to use graphs for AI operations and reasonings, such as linear regression, logistic regression, clustering and visual graph representation. In FEA meshing, we use graphs (its node-edge concept) as a special representation in multiple levels from small scale to large scale as noted below: (a) Traditional atomic mesh entities (e.g., mesh element and element connectivity); (b) High level mesh entities (called atomic regions) and entities links; (c) A model's multiple remesh and mesh changes in its simulation life time; (d) A model (also allowing for multiple models) and its corresponding mesh and performance's historic change in daily regression test of the software development release cycle; (e) End user's CAE models (user's privacy considerations required) and their model variations including behavior changes. The graphs "node-edge" is the kernel to building a machine learning network to discover and apply AI based automation in CAE meshing and simulation. Graph and shallow/deep learning can be extensively used in the above levels/scales to enhance the remeshing robustness and mesh quality. They are componentized and organized as a flexible multi-layer neural network to adapt a "more-is-better" approach to enable data warehousing. This in turn enables a sophisticated decision-making process in an automated remeshing process. With remeshing standing in between simulation solving and meshing, there are some pre-known knowledge and geometry/mesh patterns; however, these vary model by model because of multiple factors such as initial/final geometry patterns, FEA loads/constraints and material properties, etc. These are typical patterns to be discovered by AI and adaptive learning in an automated solver-meshing process. In the meantime, meshing is generally inexpensive compared to the solver time, leaving more room for solver-meshing to do exploration, quick learning and perform adaptive decision making. These processes can be grouped as shallow learning and deep learning depending on the size of data set and the scale in simulation life cycle. Remeshing is an integral approach in the FEA mechanical simulation life cycle, and we have successfully applied it into the ANSYS Mechanical implicit nonlinear adaptive (NLAD) simulation and fracture crack growth as a remeshing engine to address simulation based on-the-fly large distortion, topology changes, and topology optimization with smooth geometry generation.

Presenter Name: Yadav, Praveen

Presenter Company: SciArt, LLC

Presentation Title: Topology Optimization: Opportunities and Challenges (P. Yadav, SciArt, LLC; Lvl: 2)

Type: Workshop

Keywords: Topology Optimization, Finite Elements Analysis, Structural Optimization, Large-Scale FEA

Session Title: Topology Optimization: Opportunities and Challenges

Session #: 1-2

Room #: 22

Abstract:

For engineering companies to be competitive, they have to create lighter and better-performing products. Given a structural problem, engineers need to figure out where and how to remove material. Often, one of the tools engineers use is finite element analysis (FEA). Unfortunately, FEA can only provide hints on where one should remove material. The actual process of carefully removing material can be arduous and error-prone. Figure 2 illustrates a few designs that an engineer might generate. There is no guarantee that the final design generated through this trial-and-error process is even close to optimal. Topology optimization is a powerful automated process for performance-constrained weight reduction. It relies heavily on FEA, but it automates the process of material removal, resulting in a highly optimized design. Topology optimization provides rapid solutions to design problems, shaving weeks off product development cycles. There are several topology optimization methods and software implementations. Underneath, all of them rely on FEA and optimization techniques. They however differ on the specific FEA method, the optimization technique, the number of iterations required, ease-of-use, constraint handling, multi-load and multi-physics capabilities, etc. There is a lot of excitement today in 3D printing (additive manufacturing). Through 3D-printing one can fabricate parts of virtually any shape. It offers several advantages over traditional manufacturing, and has the potential to revolutionize the way things are made. Topology optimization directly caters to 3D printing in that the output from topology optimization is typically an STL file, that can be directly 3D printed. Further, for most 3D printing processes (especially, metal 3D printing), material reduction is critical, and through topology optimization, one can dramatically reduce the amount of material used in a design. In the workshop, the opportunities presented by topology optimization will be explored through hands on approach tackling some of the challenging design problems. No technology is perfect, therefore a strength and weakness analysis is necessary when it comes to utilizing topology optimization to its best effect.

Presenter Name: Yang, Yan

Presenter Company: BISME

Presentation Title: Simulation Data Management and Process Automation at Beijing Institute of Space Mechanics and Electricity (BISME) – Goals and Successes (Y. Yang, BISME; Lvl:)

Type: Presentation

Keywords: Simulation Governance, SPDM, Simulation Automation, CAD/CAE Integration, Democratization of simulation for designers

Session Title: Democratization 4

Session #: 2-2

Room #: 23

Abstract:

Beijing Institute of Space Mechanics and Electricity (BISME) is one of the earliest research facilities engaged in space technology in China, including research, design, production and testing, and is the main manufacturer of space-based remote sensors for China. During the design and development of optical remote sensor products, BISME has used simulation (CAE) for nearly thirty years, accumulating a great deal of analysis process best practices and data for each discipline and requiring BISME to manage the simulation data and processes effectively. However, an important problem for BISME to tackle is how it can improve the level of simulation capabilities for optical remote sensors and achieve the overall optimization of system level performance. In this presentation, BISME will discuss how it leveraged a CAE platform and workspace that provided powerful capabilities for managing simulation data and capturing simulation processes and rules for reuse. This has allowed BISME engineers to better manage their simulation data, including material databases, geometric models, mesh models, and simulation processes for automation (load cases, boundary conditions, simulation tasks and simulation rules). Additionally, this platform has enabled the creation of simulation applications that automate various processes including multiphysics/multi-tool simulation that runs in the background, dealing with the results of multiple simulations, and automatically generating simulation reports. These regular tasks are now managed safely, effectively, and accurately, and can be performed consistently across different departments. With the ability to interact with a wide array of tools from multiple vendors (CAD, CAE, PLM, & Math tools) within a single automation process, BISME engineers avoid manual errors, redundant work and rework, and the time that is often lost when dealing with different formats of data and units conversion. By implementing web-deployed simulation apps (templates), ordinary users (designers) can now perform simulation work safely via their desktop web browser. The server side provides high performance analysis and computation and massive data storage capacity, effectively avoiding big data transmission between the networks and the need for high performance computers on the engineers' desktops to perform simulations. The simulation efficiency of optical remote sensor design has been increased by an average of 50% by using standard simulation automation templates for structural, modal, thermal, and optical analyses, and by integration of these disciplines to perform STOP analysis of optical systems. BISME engineers are working on refining these templates (to make them more accurate and efficient) and on adding new templates for automating other kinds of analyses. BISME engineers believe that this is the future of simulation and will allow BISME to get a much higher return on their simulation investments.

Presenter Name: Yiming, Li

Presenter Company: ZPMC

Presentation Title: Implementing the Democratization of Simulation at ZPMC – The Goals, Challenges and Successes (L. Yiming, ZPMC; Lvl:)

Type: Presentation

Keywords: Democratization of Simulation, Simulation Governance, Simulation Driven Design, SPDM, Simulation Automation, CAD/CAE Integration, Non-Experts Accessing Simulation

Session Title: Democratization 5

Session #: 3-1

Room #: 23

Abstract:

ZPMC is a global organization dedicated to the design, manufacturing and maintenance of heavy equipment that is used in various customer applications. Its main products include large-scale container machinery and bulk cargo handling machines, offshore heavy-duty products, heavy-duty steel structures, energy-conservative and environmentally-friendly equipment and related accessories. The container machinery products can be seen in 99 countries and regions all over the world – ZPMC has captured more than 70% of the world market share of these products. ZPMC now has more than 2800 engineers who engage in product design and development. During their product design process, simulation plays a very important role to help verify product performance before these expensive machines are manufactured. ZPMC has found that current simulation tools used in the analysis and design of their products can only be successfully used by a tiny fraction of their engineers – by only the simulation tool experts. This is a barrier to speeding up the deployment of new products and to improving the quality of the products that are released to the market. Over the last year, senior engineers at ZPMC have been working with the implementation team at Comet Solutions to develop and deploy automation templates and CAD-embedded custom user interfaces to significantly increase the number of engineers that can design and analyze cranes rapidly and accurately, without being simulation experts. The initial Phase 1 implementation called ZQE has demonstrated the efficiency of this approach for the quayside crane product family. The amount of time that it now takes to create the simulation model for a new crane design has been reduced significantly and it is no longer necessary to be a simulation expert. The authors will describe the challenges that were faced during the implementation and the successes that were achieved. This initial, success story has led to a desire to expand the use of these highly efficient technologies and automation approaches into every aspect of ZPMC's business - the bidding process, concept design, detailed design, manufacturing and maintenance, followed by cycles of product improvement. The authors will provide a high-level view of this vision, the goals of this enterprise-wide effort and how their customers will eventually benefit from this investment. A primary piece of the infrastructure that will support this broad vision is the Crane Information Model (CIM) - a data model that defines and supports all the data required to design, manufacture and maintaincranes. The CIM is a derivative of Comet Solutions' product engineering data model, the Abstract Engineering Model (AEM), and will provide ZPMC engineers with a single, consistent data representation of their highly-engineered products, across all the diverse tools that will be used in the various functional divisions at ZPMC. An initial definition and implementation of the CIM now exists in the quayside crane analysis environment that was implemented in Phase 1 (ZQE). The authors will present a high-level view of the CIM, the expected benefits of defining and using a product-specific data model, and its role in democratizing the product engineering process at ZPMC.

Presenter Name: Yu, Wenbin

Presenter Company: Purdue University

Presentation Title: Multiscale Modeling of Composite Structures Using Mechanics of Structure Genome (W. Yu, Purdue University; Lvl: 2)

Type: Training

Keywords: Mechanics of Structure Genome, SwiftComp, Multiscale Modeling, Structures

Session Title: Multiscale Modeling of Composite Structures Using Mechanics of Structure Genome

Session #: 1-2

Room #: 21

Abstract:

Mechanics of structure genome (MSG) is a revolutionary approach recently discovered for multiscale constitutive modeling of any structures featuring anisotropy and heterogeneity. MSG directly connects materials with structures: a top-down approach without invalid scale separation and assumptions within scales. For 3D structures, MSG can be shown to be a much better alterative than many available semi-analytical and numerical micromechanics approaches including but not limited to asymptotic homogenization and RVE (representative volume element) analysis. MSG can achieve accuracy of direct numerical simulations at efficiency of simple engineering models and models composites as simple as metals, capturing details as needed and affordable. Finally, MSG can power conventional structural elements available in standard FEM software such as Abaqus, Ansys, and Nastran with accurate composites modeling. This 1.5-hour training course covers fundamentals of MSG needed for multiscale modeling of composite structures through directly linking structural analysis and microstructures. Attendees with good understanding of elasticity, finite element method, and mechanics of composite materials should have no problem to complete and benefit from this short course. This course not only covers the essential theoretical fundamentals of MSG including the concept of structure genome and the principle of minimum information loss, but also the companion software SwiftComp to solve typical problems in composite structures. On completing this course, the attendees shall be able to: 1. Understand the concept of structure genome (SG) and its difference from other micromechanics approaches including representative volume element (RVE). 2. Understand the principle of minimum information loss. 3. Apply MSG to solve practical problems including 3D properties of laminates, interlaminar stresses of composite laminates, buckling/postbuckling of stiffened composite panels, multiscale modeling of textile composites. 4. Analyze composite structures using SwiftComp and other commercial composite simulation software This training course will not feature a presentation, but also real computer exercises for attendees to obtain hands-on experiences. The computer exercises will be conducted through the composites design and manufacturing (cdmHUB.org) to handle possible scalability issue and incompatibility of software systems.

Presenter Name: Yu, Wenbin

Presenter Company: Purdue University

Presentation Title: How to Use cdmHUB as a Cloud Collaboratory for Simulation-Based Composites Design and Manufacturing (W. Yu, Purdue University; Lvl: 1)

Type: Workshop

Keywords: Composites, Manufacturing, Cloud Computing

Session Title: How to Use cdmHUB as a Cloud Collaboratory for Simulation

Session #: 2-1

Room #: 25A

Abstract:

Purdue University has launched Composites Design and Manufacturing HUB (cdmHUB.org) as a collaboratory for the composites community come together to create, collaborate, share, publish, teach, and learn. The goal is to leverage the power provided by the cloud computing to enable the next generation composites innovation. cdmHUB contains three types of capabilities: 1) groupware & collaboration services; 2) simulation capabilities & middleware; and 3) a content management and dissemination system. Many other websites only have a subset of the collaboration services, mainly the blogs and forums. cdmHUB collaboration services also include wikis, projects, files, and groups, calendars, announcements. Different permission levels can be assigned to the information to be shared so that users can decide when to share what with whom. The simulation capabilities & middleware are unique and powerful. Users can launch codes on cdmHUB directly on any devices connected to internet. Users can also develop and disseminate computer codes in a collaborative environment. Users can have finger-tip access to scalable on-demand HPC powered by Amazon Web Services. In the very near future, users such as a researcher does not have to buy their own workstations or clusters for their group, they can easily spin up desktop or HPC virtual machines on cdmHUB. Regarding cdmHUB's capability in content management and dissemination system, simply speaking, cdmHUB allows you to publish papers, datasets, videos, computer codes, etc with a DOI. To date, cdmHUB hosts 30+ simulation tools for cure kinetics, laminate theory, lamina analysis, micromechanics, strength prediction, shear lag and multiscale structural analysis. In this workshop, we will provide hands-on training on making use of these three types of functionalities of cdmHUB to facilitate collaboration in composites research and development. Particularly, the following topics will be covered. 1. How to use cdmHUB to create account, interact and network with others, and share and resources, ask and answer questions? 2. How to use cdmHUB to establish your own professional group in the cloud? 3. How to use cdmHUB for data and project management? 4. How to use cdmHUB to collaboratively develop a code? After completing the workshop, the students should be able to confidently use cdmHUB for collaboration needed for composites design and manufacturing, powered by unique capabilities for developing and launching simulation codes.

Presenter Name: Zanoni, Rodrygo

Presenter Company: Siemens Gamesa Renewable Energy B.V.Brunel Netherlands

Presentation Title: Taking Simulation to the Next Level - Finite Element Model and Engineer (R. Zanoni, Siemens Gamesa Renewable Energy B.V.Brunel Netherlands; Lvl: 1)

Type: Presentation

Keywords: Finite element engineer and training

Session Title: Simulation Governance: Qualification of Simulation Personnel

Session #: 3-3

Room #: 23

Abstract:

The first thing that comes to mind when you think about taking simulation to the next level is better software and hardware. But in general software and hardware are acceptable and enough for most of our daily analyses. The finite element calculations may present errors of around 10% or more due to lack of quality and proper input on the finite element model. This error can be associated with both the discretization of the geometry as well as discretization of the solution. There is no doubt that finite-element analysis has a big role in development projects. One reason is that it helps reduce expensive prototype testing and design cycles. This technology is also seen as another way to improve product integrity. Despite FEA's reputation for accurately pinpointing weak spots in designs, a few faulty assumptions and organizational flaws may render analysis work unusable. For instance, some companies treat FEA as an extension to CAD packages. In fact, it requires specialized training all its own. In this presentation we summarize some of these basic mistakes and some thoughts on how improve a lot the accuracy of the analysis results. What could possibly go wrong? Improper boundary conditions may lead to wrong results and decrease the confidence on your numerical simulation. The load types must reflect as much as possible the actual physical problem. And the way of its application should be engineering judged according to the project that is being analyzed. The conclusion is to increase confidence in numerical simulation there is a need to train and instruct properly the engineers regarding software, hardware and the most important about finite element method in theory and in practice. Rodrygo Zanoni Tower Finite Element Specialist Engineer Siemens Gamesa Renewable Energy / Brunel Netherlands Rotterdam Airportbaan 19 3045 AN Rotterdam Netherlands Mobile: +31 0 633586768 mailto:rodrygo.zanoni.ext@siemens.com

Presenter Name: Zebrowski, Mark

Presenter Company: Consultant (Ford Motor Company, Retired)

Presentation Title: What's Wrong with Simulation, What Happens if It's Not Fixed, and How to Fix It (M. Zebrowski, Consultant (Ford Motor Company, Retired); Lvl:)

Type: Workshop

Keywords: Lean Simulation, Long tern View, Rework, Strategies Tactics and Operations

Session Title: What's Wrong with Simulation, What Happens if It's Not Fixed, and How to Fix It!

Session #: 3-1

Room #: 22

Abstract:

Tag Line: What's it Worth to You for You to be the Key to Producing High Quality Products and Services for your Customers? And have Fun doing it … Come with Us Mark Zebrowski will present 2 papers, one as a Presentation – one as a Workshop. With the same titles and tag lines. But with an increased level of content and detail during the workshop. Simulation, as a tool for functional performance evaluation, has been used in the engineering community since the late-1960's and has experienced rapid growth during the last two decades. However, its effectiveness as a tool to replace physical testing widely varies from company to company and across various functional attributes. Like many computer-based techniques, its return on investment (ROI) has been somewhat less than initially promised and the confidence and trust in its predictive capability is, in many instances, not sufficient for companies to move to a virtual predictive world from physical testing. These presentations propose that further advancement in Simulation will be the result of, not from further technological and/or software development, but from a shift in thinking – in not treating Simulation as a technology, but as a business – in treating Simulation not as a "craftspersons" or "analysts" tool, but as a general engineering tool – in treating Simulation not as a craft, but as a robust, repetitive, consistent production business – in growing Simulation so that, in the face of constantly increasing demand, it can be scaled to meet the demand at high levels of quality. Mark will discuss 1) Why a 5 Decades View Point on Simulation is Necessary 2) What's Currently Wrong with Simulation 3) Why Companies that Seem Well Positioned with People, Processes, Tools and Methods can produce Poor Quality Predictions 4) What Happens? - When (If?) The Prediction Quality is Discovered 5) Why we tend to Produce Laundry List of Tactics – and Call them Strategies 6) How do We Produce A True Solution – A Leader's Solution - A Grand Strategy, Sub-Strategies, Tactics, and Operations 7) What the "New World" Looks Like 8) Our Call to Action – Don't Expect a "Silver Bullet" or One "App" to Cure your Strategic Deficiencies - It Takes Multiple Technologies - It Takes a Vision, a Grand Strategy to Make it Happen Simulation is sometimes relegated to the sidelines of product development as companies wait in anticipation for software providers to come up with that "one thing" in terms of features and functions that will show them the way to improved quality, reduced cost structures and quicker time-to-market for innovative products. This narrow view, focusing on tactical elements only, has its roots in the early days of Simulation, when companies were concerned about details such as element formulations, mesh generation speeds and compute power and other technology-related topics of endless debate. Some remain stuck in this time warp, still searching for newer and better technology when experience has shown that tactical solutions alone won't solve a company's strategic and operational problems. Significant changes in Simulation implementation come about when you begin to broaden your view in considering what's really important for Simulation: the overriding strategy of establishing Simulation Processes and integrating them into Product Development.. In this broader view, the role of Simulation is elevated to that of a general engineering tool, not just one to be used exclusively by "craftspersons" and dedicated analysts. Mark Zebrowski (markzebrowski1625@gmail.com) spent 32 years working in Simulation at Ford Motor Company and was a technical manager for 12 years prior to his retirement in 2005.

Presenter Name: Zhao, Lei

Presenter Company: Pepsi Co

Presentation Title: Investigation of Random Extrusion Process through Computation Fluid Dynamics Simulation (L. Zhao, Pepsi Co; Lvl:)

Type: Presentation

Keywords: Random Extrusion, CFD, Extrusion, Non-Newtonian Fluid, Food Engineering

Session Title: CFD 1

Session #: 1-1

Room #: 26A

Abstract:

Extrusion is an important processing technology widely used in the food industry to produce a wide range of products including snacks, breakfast cereals, pastas, and many others. Crunchy corn curls, a widely popular snack, are made on the random extruder (Morales & Rao, 2017). The physical and chemical processes in the random extrusion are of great complexity complicated by material rheology, multiple phases of liquid/gas/solid, and abrupt temperature/pressure variations. Detailed measurement of flow, temperature and pressure inside the extruder is extremely hard to acquire due to limited spacing, high pressures and existence of moving parts. Computational Fluid Dynamics (CFD) modeling tool is employed in this study to gain insights in the random extrusion process. Application of this research is aimed to provide key understanding in support of a throughput boost on the random extruder without impacting product characteristics. CFD results from the models provided an estimation of the velocity flow profile through die head, pressure, and temperature due to heating from viscous dissipation. A critical parameter, Specific Mechanical Energy (SME) for system was calculated from the model and used to characterize the product. CFD models are validated through experimental data of the product temperature and motor mechanical power inputs. Close comparison is achieved validating the model. The model is then used as virtual test bed to evaluate and understand how die head geometry and feed rate impact the random extrusion process, and to develop a die head that will deliver a 25% throughput boot. Models of various level of complexity are developed as a progressing strategy to minimize computational cost while still capturing the key physics. Single phase static model with constant temperature was first developed as an attempt to capture the flow physics only without an overly complex model. Then the effect of rotor motion, heat transfer is added into the single phase model to capture the importance of other physics. Lastly a high complexity two phase modeling, including the liquid extrudate and air, with the Volume of Fluid method (VOF) used to capture the interphase physics. Experimental data of both product temperature and motor power inputs show that the two phase model is a close representation of the real system based on the accuracy of the values predicted. It also proves that the simplified model produces a good enough estimate for capturing the SME which is critical in characterizing the product quality.

Presenter Name: Zouani, Karim

Presenter Company: Ford Motor Company

Presentation Title: Microstructure Optimization for NVH Improvement - Application to SFRP Engine Mount Bracket (K. Zouani, Ford Motor Company; Lvl:)

Type: Presentation

Keywords: NVH, Powertrain, Plastic

Session Title: Optimization 1

Session #: 1-1

Room #: 22

Abstract:

K. Zouani, H. Nehme and M. Felice, Ford Motor Co. S. Calmels and R. Roger, e-Xstream A. Gokhale, Esteco Abstract The increasing demand for vehicles weight reduction is driving Automotive OEMs to expand the use of short fiber reinforced plastic (SFRP) components to the under-hood applications. Benchmarking of production powertrains reveals that SFRP is commonly used for large components such as oil pans, valve covers, intake manifold and non-structural engine front covers. More recently, the use of the SFRP material was extended to the active side of the powertrain mount brackets. SFRP material includes a resin and filler; the resin is typically thermoplastic and the filler is made from glass fiber, carbon fiber or sometimes natural fibers. The viscoelasticity behavior of the SFRP material is dominated by the resin while its stiffness is dominated by the filler. The SFRP materials are injection molded with fibers that have aspect ratios ranging from10 to 25 (ratio of fiber length/ fiber diameter). In contrast with metallic components, implementation of SFRP components is very challenging due to the high temperature environment and the reduced stiffness inherent to this type of material. These challenges increase the risks for objectionable noise and vibrations associated with these components. The components macro-behavior is driven by its micro-structure resulting from the injection molding process that creates a heterogeneous distribution of the fiber orientation. Consequently, the local component behavior will be driven by the anisotropic nature of the SFRP material. For this reason, the simulation of the NVH performance of such components requires a material model that captures this local behavior. The design of these components should not be limited to the optimization of the geometry but extended it to include the choice of the material (resin and filler) and the optimization of the fiber orientation. This paper presents an integrated analytical process to optimize the material microstructure for improved NVH performance of SFRP components. The process combines: (a) Anisotropic material modeling, (b) Mold flow analysis, (c) Finite element analysis and (d) Multi-disciplinary optimization. Results obtained in the case of an engine mount bracket will be discussed in this paper. In this case, the impact of the material microstructure on the dynamic compliance of the bracket will be studied.