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Abstracts & Biographies

Presenter Name: Allan, Mark

Presenter Company: Zenotech Ltd.

Presentation Title: Rapid Stochastic Broadband Acoustics on GPUs

Session Title: 1A Optimisation

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:20

Keywords: High Order CFD, Acoustics, CFD, FRPM, Stochastic, Noise, Automotive, Aerospace

Abstract:

Computational Aero-Acoustics (CAA) is increasingly important across a range of engineering sectors including aerospace and automotive to reduce and manage environmental noise pollution and to enhance the customer experience of new vehicles â€“ particularly electric cars. Within aerospace, acoustic engineering is focused on parts of the airframe known to generate noise â€“ including the landing gear. Current methods for predicting noise sources and propagating the sound make use of either semi-empirical methods or fully scale-resolving simulations. Semi-empirical methods provide rapid noise predictions however are of limited scope. Full scale resolving simulations can often require several days or weeks of run-time on large scale supercomputing facilities. The timescales for simulation turnaround are prohibitive for inclusion in the early design stages. Zenotech has recently developed a Fast Randomised Particle Mesh method (FRPM) - a CFD-based stochastic broadband acoustics technique that has been shown to be significantly faster than full scale-resolving methods. We present two open test cases from the international BANC workshop on airframe noise computations, which are excellent benchmarks. The first test case â€œLAGOONâ€(LAnding Gear nOise database and CAA validatiON) is a relatively simple geometry with complex physics. The second test case is a complex test case with lots of geometric features called the â€œPDCC NLGâ€(Partially-Dressed Closed Cavity Nose Landing Gear). This case is representative of the type of geometry that we would expect from aerospace landing gear design processes. The toolchain includes a RANS step that can either use existing RANS CFD data in a variety of common formats, or generate new data. The stochastic source generation is very rapid, and can be run in a fraction of the time for the RANS solution. Propagation of the noise sources is via a high order CFD method that can run on modern GPUs. The results are shown to be as accurate as current scale resolving methods and are 10x - 100x faster to produce.

Speaker Biography:

Mark Allan is a vibro-acoustics specialist with many years of experience developing advanced software for the aerospace and maritime sectors. Following a PhD and post-doctorate in the fluid and flight mechanics of highly swept wing configurations, Mark Allan provided technical support and training for a wide range of CFD applications at ANSYS. Mark Allan joined BAE Systems ATC in 2005, where he was the lead for computational hydro-acoustics methods concept and development – providing capability to Type 45, Type 26, the Successor programme, and the Ministry of Defence. Mark is the lead for development of state-of-the-art Computational Acoustics software and high-order methods for Computational Fluid Dynamics.

Presenter Name: Horgan, Sean

Presenter Company: 8020 Engineering Ltd

Presentation Title: Automated Shape Optimization Technology Coupled with UpFront CFD

Session Title: 1A Optimisation

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:45

Keywords: UpFront CFD, Shape Optimization, Robust Design, Democratization, CFD Simulation, Automation

Abstract:

'Robust Geometry Variation for the CFD-Driven Optimization of Complex Geometries'. One of the main challenges in CFD-driven shape optimisation is the flexible and robust parametric variation of complex – often free-formed geometries, keeping the number of degrees-of-freedom within reasonable bounds and taking into account all necessary constraints. This paper introduces a new state-of-the-art workflow based on combining a specialized software tool (CAESES) with any of the flow solvers found in use within industry today. CAESES is a dedicated and highly specialized CAD environment that addresses the aforementioned parametric variation challenge and is being used in industries like energy, maritime, and automotive for applications such as turbomachinery, ship hulls, and engine components. The paper will present a case study featuring a Hydraulic Spool Valve from 'Duplomatic Motion Solutions' based in Italy. The goal was to optimize the valve to achieve the highest mass flow rate possible through the modification of the various internal channels. Ten geometrical parameters were set-up to be varied and nearly 250 CFD runs automatically involving Design of Experiments (DOE) to capture the most influential parameters followed by the optimization of the best designs identified. The study will present how CAESES and Simerics-MP (CFD Solver) resulted in an improvement of 8.65% on the mass flow rate and was undertaken 10 times faster than using the more traditional iterative design and CFD simulation process. The key was the combined workflow automation and optimisation capabilities, bringing the whole process into one design environment. 'Introduction to UpFront CFD'. With the rapid development in computer technology over the last decades, both in terms of computing power and affordability, the use of simulation – specifically CFD – has increased significantly. Not only is CFD being utilized to a much larger extent, reducing the need for physical testing, but also earlier in the product development process. As opposed to using CFD late in the design process, where it can merely serve for validating a completed design or give some guidance for late changes, employing it early in the process turns it into a real design tool. UpFront CFD is the obvious first step in achieving this but then how does an organization get to evaluate all the many design variants that are possible before making a decision to manufacture? This paper presents a possible solution to this question.

Speaker Biography:

A Mechanical Engineering graduate (Hons) from Bradford University in the UK in 1988. Sean Horgan has now been working within the CFD/CAE industry for over 30 years. Starting his career as an early user of FEA and CFD technology within a number of product development companies including Philips Defence Systems and Colt International. Then initially moved over to work for CHAM, the first ever commercial CFD vendor who developed the PHOENICS software and then onto a variety of other software companies (AEA Technology (CFX), IBM (CATIA), Blue Ridge Numerics (CFdesign)) helping to implement hundreds of different CFD/CAE/CAD systems successfully throughout the world prior to the formation of 80/20 Engineering. Sean is currently the Managing Director and one of the founder members of 80/20 Engineering, a simulation solutions and services business set up at the end of 2009. Sean's role is to oversee the successful use of CFD/CAE technology within their client's product development process through the deployment of design driven CFD/CAE tools. This also often involves the provision of high quality CFD/CAE services, if and when their client's resources or skills are stretched or in need of additional help. Sean and the 80/20 Engineering team currently use Simerics-MP+ and CFdesign for CFD, CFturbo for Turbo-Machinery Design, CAESES for Shape Automation and Discovery SpaceClaim for simulation model preparation.

Presenter Name: MacKenzie, Gordon

Presenter Company: Leonardo MW Ltd

Presentation Title: Using Optimisation in the Design of the RWUAS Air Vehicle Structure

Session Title: 1A Optimisation

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 10:55 AM

Keywords: Optimisation in Conceptual Design Phase

Abstract:

The Rotary-Wing Unmanned Air System or RWUAS, is one of the latest unmanned capabilities being developed by Leonardo. It is a highly configurable multi-role Vertical Take Off and Landing (VTOL) vehicle with modular bays for a wide variety of mission payloads. This wide variation in usage creates significant challenges in producing an optimum light weight, cost effective structure. Optimisation is a key element in maximising the potential of any product. The intention with this project is to explore the use of optimisation for the structure from the very early stages of the conceptual design phase right through to the development of the mature design. Instead of focusing solely on minimising mass, a more holistic multi-disciplinary approach will be adopted involving a broad spectrum of functions. The above strategy requires a tool which will allow a complex, multi-objective simulation to be performed based around a finite element model but also using equations to define custom responses and other tools such as MS Excel to create auxiliary models. Furthermore, in the conceptual phase the overall design is very fluid, continually changing and evolving. This requires a suitably flexible tool. The HyperStudy tool developed by Altair was chosen to meet these needs. This allows a Design of Experiments approach to be taken from which a meta-model can be created allowing rapid trade studies to be performed. To maximise the potential of this, careful planning is required to ensure suitable input variables are selected from the beginning. For example, the applied loads are included as the design loads usually evolve considerably as the design matures. The optimisation is performed using the meta-model and a mixture of shape and sizing design variables from the FEM, material selection models built in MS Excel and an in-house developed costing algorithm. It is performed in two phases. The first looks at how the required mission profiles affect the structural weight. This is done to inform the mission selection choices. Here we are looking to see if a particular mission profile is a significant weight driver. The output from this can be considered commercially against the overall marketing strategy for the product. The second phase then looks at the best sizing and material combinations which can be obtained while trading cost and weight. The above two phases provide the best conceptual architecture to review at a PDR level. Once the final mission profile is agreed the corresponding architecture can be developed at a more detailed level using a more conventional optimisation approaches throughout the rest of the design phase.

Speaker Biography:

I joined what was then Westland Helicopters in 1989 after obtaining a degree in Aeronautical Engineering from The University of Glasgow. I began my career in the Mathematical Modelling Department using FEM for structural dynamic problems before gravitating into the world of stress analysis. Starting off as a Stress Engineer I then became Deputy Chief Structural Engineer for the EH101 helicopter before becoming the Chief Structural Engineer for the AW159 product. After also spending a bit of time in the world tilt rotors I am now responsible for the methods development for the Airframe Structures Department at Leonardo Helicopter Division where I have a particular interest in the application of structural optimisation techniques.

Presenter Name: Ahdab, Sam

Presenter Company: Mott MacDonald

Presentation Title: The Development of Machine Learning Tools to Automate and Improve on the Identification of Invasive Non-native Species and Help Keep Boots off Ballast

Session Title: 1B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:20

Keywords: Machine Learning, Artificial Intelligence, Digitisation, Asset Management, Engineering Data Science

Abstract:

Background: Invasive non-native species (INNS) pose a threat to asset owners. Their management and control, particularly Japanese Knotweed, have been largely ineffective. The development of this new tool is part of an ongoing effort to improve the methods used to understand the exact extent of invasive species, develop a historical record of their spread and simulate their future spread. The aim was to provide a resource that will inform the management efforts while providing time savings and keeping boots off ballast. Methods: The development was undertaken by the Intelligent Data Analytics team at Mott MacDonald. We applied the best in class machine learning technologies to pre-collected and already available data sources. For the first task, an in-house object detection single-shot-style deep neural network, based on the YoloV3 research project (Redmon et al., 2018), was developed. This algorithm was trained using the data from a previous project that the ecology team at Mott MacDonald undertook using traditional methods. The previous project involved identifying four species of INNS from cab footage collected from the front of trains across rail tracks in South Wales . The algorithm was trained to perform the same task as the ecologists for Japanese Knotweed. The data from the previous project did not include sufficient instances of the other INNS along the CVL to effectively apply this methodology. For the second task, a second in-house algorithm was developed. It is an object detection and instance segmentation algorithm that is an adaptation of the Mask R-CNN research project (He et al., 2018). This algorithm highlights the pixels in an image that belong to an identified object. The data from the first task in addition to the data from the previous ecology project were used to train the algorithm to identify Japanese Knotweed in 4cm per pixel aerial imagery of all rail right of way in Wales. Results: Results from testing of the first task yielded a very strong match to the manually-labelled data over the same patches of railway. Even with the limited labelled data used, the INNS detection tool correctly identified 93% of all instances of INNS within the test area. The second task is currently in the final stages of development and testing but has shown to accurately identify areas of INNS and provide quantified extents of INNS within a sample area. Conclusion: The devised methods successfully identify instances of INNS along the rail track using cab footage. The development of task 2 provides quantified areas of instances of INNS. The application of this tool across the UK combining input data from multiple datasets (aerial imagery, satellite, linear asset imagery) could develop a holistic approach to identifying the presence and spread of INNS and feed directly into growth prediction models, on a much greater and more effective scale, to inform future asset management strategies. The successful deployment of the INNS tool forms part of the efforts of the Mott MacDonald Intelligent Data Analytics team to tackle issues through the combination of state-of-the-art machine learning algorithms with large datasets within the field of asset management. Other implementation, for example, wet beds, retaining walls, structural defects, ash dieback, and biodiversity net gain, are underway.

Speaker Biography:

Civil Engineer specialising in the application and development of AI for use in civil engineering. My current role consists of working on innovative AI projects from proof of concept through to implementation. My work experience includes the development of machine learning algorithms and the use of advanced technologies, such as drones, for surveys and inspections; inspection technology specialist and innovation advisor to the High Speed Two (HS2) project; and inspections and level 1 and 2 assessments of bridges and other civil structures.

Presenter Name: Bi, Jing

Presenter Company: Dassault Systèmes SIMULIA Corp

Presentation Title: A New Method for Fast Finite Element Explicit Crash Simulations

Session Title: 1B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:45

Keywords: Explicit, Crash, 3DEXPERIENCE, optimization, machine learning, DOE

Abstract:

Today, automotive crash finite element simulations are one or two orders of magnitude slower than stiffness, NVH and ride & handling simulations. Experimental validation studies show that fine meshes around 2mm are required to capture the metal folding behaviour with reasonable accuracy (10%). In addition, the stable time increment for explicit crash simulations is extremely short due to the small mesh sizes and the very high metal speed of sound. Therefore, a reasonably accurate full car crash simulation with 10 million elements will take more than three hours of simulation time, even when hundreds of cores are applied. We present a new method to accelerate finite element explicit crash simulations by one or two orders of magnitude in order to enable multi-disciplinary concept and optimization studies. Since the collapse of thin walled structures is very dependent on local bending, torsion and compression conditions, it is critical that we represent the geometry with enough geometric refinement to support the concept design and with enough accuracy to match fine simulations to within about 15%. Our hypothesis was that the discretization error could be corrected out a priori for each mesh element on the basis of mesh geometry and material properties. For this purpose, we created a very large design of experiment study, which varied mesh geometry properties, material properties, material correction factors, component geometry characteristics and loading conditions. As outputs of the study we compared reaction forces, deformations and absorbed energy. We then captured the space with a machine learning interpolant and reduced the dimensional space to material stress-strain correction conditions whereby the outputs of the fine mesh matched the coarser mesh. The material correction factors could then be applied a priori to complex components such as automotive S-beams and conceptual frontal structures without the need for iterative fine mesh calibrations. To illustrate the power of this approach, we applied it to the design of 20 components of a simple conceptual automotive structure in a 55 km/h frontal crash scenario. The purpose of the design optimization is to reduce the driver accelerations to 35 g and limit the structural deformations to 550 mm. Such a structure is hard to optimize because changes in a single component can change the collapse sequence of the beams, thus creating a bifurcation in the crash response. We achieved good results in just 10 Adaptive DOE iterations, each iteration submitting all 50 frontal crash simulations in parallel, each simulation on multiple cores. The parallel nature of ADOE decreased the optimization time by a factor of 20, whereas the corrected coarse mesh simulation reduced the simulation time by another factor of 30, bringing the frontal crash optimization process from a month to less than an hour on the 3DEXPERIENCE platform.

Speaker Biography:

Not Provided

Presenter Name: Islam, Murat

Presenter Company: John Crane UK Ltd

Presentation Title: Torsional Stiffness Simulation of Metallic Disc Membrane Couplings Considering Pre-Stretch and Post-Buckling Behaviour

Session Title: 1B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 10:55 AM

Keywords:

Abstract:

Speaker Biography:

Murat Islam is a Design Engineer at John Crane UK Ltd based in Manchester, where he develops and tests standard and high-performance Power Transmission Couplings for the Process Industries. Murat has previously worked in the aerospace, offshore and renewables industries in Manufacturing and Design Engineering capacities, and he has a highly commercialised Patent in Ducting for subsea cable protection applications. Murat has studied Mechanical Engineering at Black Sea Technical University, Mechanical Engineering Design masters at the University of Manchester and Project Management Postgraduate Certificate at Robert Gordon University. Murat is a STEM Ambassador and he became a Chartered Engineer through the Institution of Mechanical Engineers. Murat has chaired the IMechE's Lancashire Area Committee through which he facilitated many technical events and webinars for the engineering community. Murat has recently been appointed to IMechE's Young Members Board, representing their Process Industries Division. Murat is a keen STEM Ambassador and Primary Engineer advocate. In his free time, Murat enjoys learning from his connections on LinkedIn. Murat also enjoys caravanning with his wife and their dog, and he can't wait to visit his parents in Trabzon, Turkey.

Presenter Name: Bewsher, Stephen

Presenter Company: AVL List GmbH

Presentation Title: Optimization of Piston-Cylinder Liner Conjunction Micro-Geometry for Enhanced Tribo-Dynamic Performance

Session Title: 1C Computational Tribology

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:20

Keywords: Computational Tribology, Asperity Friction, Lubricant-Surface Combination, Powertrain Optimisation

Abstract:

A necessity for the automotive industry to manufacture more efficient vehicles is a key driver for innovation, with strict emissions legislations set across the globe targeted at reducing the effects of greenhouse gas emissions. Looking at the behavior of consumers in European Union countries as an example, a significant shift in market share for buying passenger cars with lower emissions can be observed over the last decade with new technologies such as hybrid, electric and fuel cell powered vehicles emerging into the market [1]. Recent reports from the European Union show that they believe the hybrid and pure internal combustion engine market share for passenger vehicles in 2050 will still be over 90% [2]. The reduction of frictional losses within the tribological components in powertrain systems such as bearings, pistons, gears and clutches contribute towards an overall increase in efficiency of a vehicle [3]. This can lead to several key benefits, for example, a reduction in overall fuel consumption, engine power output increases, reduced oil consumption, reduction in harmful emissions from the exhaust, improved lifetime durability for components and systems as well as the whole engine, which in turn can lead to longer service intervals and reduced maintenance costs for consumers. The simulation of computational tribology often plays a key role, where high fidelity models are used to replicate real-world engineering problems and phenomena, allowing multiple new and enhanced design iterations to be made in a short period of time. This paper presents a system level multi-scale approach to modelling a single piston-cylinder assembly for a 4-stroke C segment passenger vehicle. The principle focus is on the micro-geometry within the piston skirt-liner tribological conjunction. The simulation is performed using AVL EXCITETM. The investigation considers the use of optically measured topographical data to enhance the accuracy of the simulation algorithm by incorporating experimental data into the model. The model considers the effects of the measured local surface roughness and orientation parameters as well as cavitation. These characteristics are then utilized to calculate flow factors which can be used in the averaged Reynolds equation for simulation of the mixed lubrication regime effects. The system dynamics are also taken into account by the simulation model. A design of experiments for optimization is then carried out for the conjunction with the aim to reduce the friction caused by the asperity interaction when not enough oil film is within the contact. Results show that by optimizing the micro-geometry within the piston skirt-liner conjunction that the effects of asperity friction are reduced; thus, less wear will occur during the lifetime of the components being studied. Using this approach allows engineers to freely explore their ideas, incorporate them into a simulation model and optimize their powertrain solutions before going into prototype production and testing. References [1] European Automobile Manufacturers Association, The Automobile Industry Pocket Guide 2016/2017, Brussels: ACEA2016. [2] EU Reference Scenario 2016: Energy, Transport and GHG Emissions - Trends to 2050, EUROPEAN COMMISSION Directorate-General for Energy, Directorate-General for Climate Action and Directorate-General for Mobility and Transport, 2016. [3] Tung S.C. and McMillan M.L., â€œAutomotive Tribology overview of current advances and challenges for the futureâ€�, Tribology International. 2004; 37 (7): 517-536.

Speaker Biography:

Not Provided

Presenter Name: Dini, Daniele

Presenter Company: Imperial College London

Presentation Title: Recent Developments in Modelling Techniques to Study Surface Interactions in Tribology

Session Title: 1C Computational Tribology

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 10:55 AM

Keywords:

Abstract:

Speaker Biography:

Professor Daniele Dini is Head of the Tribology Group at Imperial College London, one of largest tribology groups in the world, whose remit is to perform world-leading research, support the application of tribology and related areas in industry and train the next generation of scientists. The Group has been awarded many awards for its contribution to outstanding research and external partnership with academic and industrial collaborators. Professor Dini is also an EPSRC Established Career Fellow since 2016 and the Director of the Shell University Technology Centre for Fuels and Lubricants at Imperial; he leads all of the advanced modelling activities and coordinates the experimental research with his colleagues. Most of these projects are multidisciplinary and range from atomic and molecular simulation of lubricants, additives and surfaces to the modelling of machine or biomechanical components. His works focuses on the development of new materials for biomedical solutions, lubricants and additives, energy efficiency in automotive and aerospace, and the development of modelling techniques and computational algorithms for industrial applications. He has published over 250 journal articles in the leading international journals and sits on various editorial boards and national/international committees. He is a Fellow of the IMechE and of the IOP.

Presenter Name: Questa, Harry

Presenter Company: Loughborough University

Presentation Title: Tribodynamic Modelling of High-speed Rolling Element Bearings using Experimentally Obtained Boundary Conditions

Session Title: 1C Computational Tribology

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 11:45

Keywords: Roller Bearings, High-Speed, Tribodynamic Model, Hybrid Electric Powertrain, Efficiency

Abstract:

Roller bearings are critical components in hybrid and electric vehicle powertrains. They are often performance limiting, and introduce NVH (Noise, Vibration and Harshness), tribological and wear challenges. The high-speed and varying load conditions of modern electric powertrains necessitates accurate modelling of the bearings to ensure satisfactory system performance and durability. Furthermore, with a push towards achieving zero-prototype development, the use of advanced simulation tools to accurately predict their behaviour at both component and system level is becoming more prevalent. For numerical analysis of high-speed bearings, the critical role of the elastohydrodynamic (EHL) film cannot be ignored. This, therefore, necessitates a tribodynamic (i.e. the combination of dynamics and contact mechanics) analysis. This work presents numerical tribodynamic analysis of elements in a cylindrical roller bearing under test on an experimental rig. The need for a full dynamic model is circumvented using novel experimental methodology for measuring insitu bearing displacement. The roller bearing undergoes a speed sweep from 0-15,000rpm with radial load applied to the shaft. The relative vertical displacement between the rigid inner and outer race is found using instrumentation on the shaft and bearing bore. A stepwise solution is performed on an individual roller as it passes through each angular position, with the displacement data used as a boundary condition to calculate 1-dimensional deflection within an explicit tribological model. At each angular position, lubricant film thickness and loading on the roller can be found. The change in film thickness over the speed sweep is observed, as well as the change in lubrication regime as the roller passes through loaded and unloaded regions. Using contact load values at specific time periods found from the explicit tribological model, a 1-dimensional numerical EHL solution based on Reynolds equation is then used to calculate the contact pressure profile in the loaded region of the roller. Results reveal that the EHL film thickness increases from 0.2 to 2 microns across the speed sweep, with peaks of 5 microns as loading conditions change due to system resonance. Calculation of lubricant film thickness in these bearing models allows for the analysis of asperity interaction and frictional power loss which is not achievable using a dry contact analysis.

Speaker Biography:

PhD Researcher in Electric and Hybrid Electric Powertrain Modelling with a focus on high-speed rolling element bearings. Graduated with a Master's degree in Mechanical Engineering from Loughborough University in 2019. Fields of interest: High-Speed Roller Bearings, Dynamics, Noise Vibration and Harshness (NVH), Tribology, Flexible Multi-Body Dynamics

Presenter Name: Choudhry, Rizwan

Presenter Company: University of Derby

Presentation Title: Multiscale modelling of random and hybrid discontinuous tow based composites

Session Title: 2A Composites

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:50 PM

Keywords: Composites Mechanics, Embedded Elements, Multiscale Modelling

Abstract:

There is growing interest in composite manufacturing industry for material solutions that offer superior specific strength, stiffness and fracture toughness while allowing for faster production rates and having lower material costs than existing materials. These are conflicting objectives and a hybrid combination of continuous and discontinuous fibre composites is a promising way forward. The development in this field is impeded because of the lack of appropriate simulation tools that can accurately and computationally efficiently reflect the material behaviour, which is highly influenced by not only the constituent properties, but also by the complex multidimensional material architecture which spans various length scales. Further development in this domain can be speeded up if appropriate simulation tools are made available to the designers, which seamlessly integrate in the existing FEA packages and require little expert knowledge for implementation on large scale industry relevant parts and structures. In this context we discuss our recently developed approach that can be used to efficiently simulate the material behaviour of components and structures made from random and hybrid discontinuous tow-based fibre reinforced polymeric composites. The proposed algorithm allows us to generate a realistic meso level representation of the random fibre and hybrid composites using shell elements through a numerically efficient scheme which is scalable for larger parts. Embedded element approach is then used to couple the meso and macro level response of the structure to carry out an accurate strength and stiffness prediction. Some of the challenges that have been overcome include the ability to capture the random change in, thickness, volume fraction, out-of-plane orientation, in-plane orientation, tow geometry and tow material, in a statistically accurate manner. This approach allows for generation of higher volume fraction discontinuous and hybrid fibre composites without penetrations and without having unrealistic fibre paths. In this presentation, the validity of the approach has been demonstrated by discussing its implementation through python scripting in ABAQUS FEA package and comparing against experimental results available in literature. The approach is generic in principle and can be easily implemented through many other finite element packages.

Speaker Biography:

Dr Choudhry is a Professional Engineer and a Fellow of HEA with research and teaching experience in the areas of computational solid mechanics, material failure and forensic engineering. He holds a PhD in composite materials damage modelling and characterisation from the University of Manchester, UK, a master's in advanced manufacturing from UMIST, UK and bachelor's in mechanical engineering from NUST, Pakistan. He has published over 50 research articles in the areas of composite materials FEA and failure analysis and has worked on several high profile research projects, including ministry of defense (MOD) sponsored work at University of Manchester, Mitsubishi Heavy Industry (MHI) sponsored work at the University of Cambridge and EPSRC and GKN sponsored work at the University of Bath. Currently he is working as Senior Lecturer at University of Derby, UK and is leading the composites modelling research in the department.

Presenter Name: Goldbeck, Gerhard

Presenter Company: Goldbeck Consulting Ltd

Presentation Title: European Materials Modelling Council

Session Title: 2A Composites

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:00 PM

Keywords:

Abstract:

Speaker Biography:

Gerhard Goldbeck holds a Diplom in Physics from RWTH Aachen University and a PhD in Polymer Physics from Bristol University. His career encompassed research in solid state physics and polymer materials by means of a range of modelling and characterisation techniques, as well as software development, product management and marketing of materials modelling software. In 2011 he formed Goldbeck Consulting Ltd, offering services focussed on increasing industrial impact. Gerhard has been involved with the European Materials Modelling Council since its beginning in 2014, as a member of the Organisational Management Board and during its EU funded project as leader of the Work Package on Interoperability. He is one of the founders of the EMMC ASBL and currently holds the role of Executive Secretary.

Presenter Name: Main, Andrew

Presenter Company: MSC Software Ltd.

Presentation Title: Supporting Innovative Composite Technologies

Session Title: 2A Composites

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:25 PM

Keywords: Composites Innovation environment optimisation

Abstract:

Composite technologies promise large environmental advantages. Looking at carbon fibre composites, the amount of CO2 emitted in making the fibres is 20 Kg per Kg of fibre. However, the expected CO2 savings for an aircraft are 1400 Kg per Kg of mass reduction, explaining the reason for aerospace adopting the material in large amounts. The advantages for automotive are less obvious at 50 kg per kg of fibre and there are significant issues with manufacturing like production speed and cost which have slowed adoption. However, there are still significant incremental improvements which can be made, reducing waste and further optimising structures. The area this presentation will cover is fibre steering. Traditional carbon fibre constructions have used fibres laid in straight lines or with small amounts of curvature. Also plies get cut out of sheets of material with ensuing material waste. This puts a limit on what can be achieved. Technologies such as automated tape laying (ATL) can put in small amounts of curvature but tailored fibre placement and continuous tow shearing enable creation of high-quality parts with small radii and minimal waste. These technologies promise up to 38% saving in mass of an aircraft wing skin. As well as structural optimisation steered fibre technologies can also be used for aero-elastic tailoring of wings and propeller blades. This controls the relationship between wing lift and torsion, enabling improved performance over a range of air speeds. The problem is that analysis tools are not available to facilitate the design using these manufacturing methods. The presentation will look at the design decision process and how optimisation can be used to enable use of these new technologies. It will also show how analysis can facilitate further optimisation and broaden the application of steered fibre composites to other industries like automotive and renewable energy. Numbers for CO2 savings are ref Toray industries Inc, http://www.torayca.com/en/aboutus/abo_003.html

Speaker Biography:

Not Provided

Presenter Name: Baksiova, Emmanuela

Presenter Company: BETA CAE Systems SA

Presentation Title: Artificially Intelligent Segmentation of a Shock Absorber X-ray CT Scan and Beyond

Session Title: 2B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:25 PM

Keywords: RETOMO, Machine Learning, CT (Computed Tomography), Segmentation, reverse engineering

Abstract:

Advances in X-ray Computed Tomography (CT) have been remarkable during the last decade and have established the above technique not only in biomedical applications, but also in a broader range of other fields like engineering. From Cone-beam X-ray Computed Tomography (CBCT) scanners that are able of achieving resolution of the order of micrometres, for nano-structure inspections, to full vehicle scanners, x-ray Computed Tomography technology is present in most sectors of the automotive industry. It is rendered a suitable technique for product quality control, design evaluation and in general, a means of â€œdigitisingâ€� an existing, real object of interest. In the Computer Aided Engineering (CAE) world, digitised real objects are ultimately converted into finite element models for realistic finite element simulations and fast product development. X-ray Computed Tomography provides a powerful, non-destructive method for achieving this even for complex multi-material assemblies. Limitations exist and are well known; however, emerging techniques and methods like machine learning can be proven valuable in the field of tomography post-processing allow for minimisation of uncertainty in material labelling and improvement of accuracy in segmentation. In this work, a CT scan of a shock absorber is virtually disassembled with the aid of RETOMO utilising newly added artificial intelligent algorithms. The final resulting model is used to inspect the shock absorber anatomy and create a model for finite element studies. Innovative machine learning algorithms introduced in RETOMO greatly reduce required user time, while improving segmentation quality. The complete process from CT data to a suitable CAE model is demonstrated through a realistic reverse engineering scenario and facilitated through the use of RETOMO and ANSA, to ensure high-quality meshed model for consequent finite element simulations. Eventually the seamless interaction of the BETA suite is exemplified through the creation and setting up of a CAE model suitable for durability analysis.

Speaker Biography:

Emmanuela is a Customer Service Engineer at BETA CAE Systems SA. She received her Diploma in Engineering from the department of Mechanical Engineering of Aristotle University of Thessaloniki in 2017. Since then, she is part of the Crash and Safety Customer Service group as well as part of the Bio-engineering team. Her interests among others evolve around Finite Element Modelling of biomedical materials and procedures. Meanwhile she is working on her MSc thesis in Biomedical Engineering at the University of Western Macedonia.

Presenter Name: Rosenwinkel, Tom

Presenter Company: Open iT, Inc.

Presentation Title: Increase CAE Productivity Levels Utilizing Machine Learning

Session Title: 2B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:00 PM

Keywords: Productivity, Machine Learning

Abstract:

Simulation software delivers your ideas and projects safely to real life. What if there was a way to harness and increase synergistic productivity of your workforce talents and simulation software? Merging machine learning with software usage sorts through copious amounts of unrelated data to establish patterns. Access to reliable real-time analytics is vital for planning on projects regarding streamlining workflow, usage trends forecasting, and allocating resources. In particular, analysis of engineering software usage requires specialized insights that take into consideration the multitudes of complex product functions and features, as well as the behaviors of engineers and other technical professionals. Precise planning is crucial in determining the cycles when users will need to use applications and in purchases of future licenses. With knowledge of future usage trends, managers can allocate resources with the benefit of foresight: pick the best time for the adoption of new technology; know the optimal time to start a new project; mitigate risks of production delays due to possible denials; and schedule the most suitable time for training. Through the utilization of a variety of statistical techniques from data mining, predictive modeling, and machine learning, these advanced analytical techniques can analyze vast quantities of historical and current usage data to create forecasts and predictions considering future usage trends. The forecasts produced by this system are highly useful in identifying risks and opportunities that allow the organization to anticipate outcomes based on the data and not on assumptions. Having a glimpse of the futureâ€¯can lead to better decision making, and proactively respond to systemic issues (including data loss), unusual user behavior or any possible risks within the system. The use of machine learning produces more precise forecasts, thus enhancing IT efficiencies and generating savings. Companies employing engineering software applications need to ensure that they receive maximum value from their license investment. Utilization of advanced analytics can optimize your software usage and productivity. Join us in our presentation as we share case studies of software optimization solutions for enterprises.

Speaker Biography:

Tom is Data Scientist at Open iT, Inc. He began his career as a full time Math professor for five years, launching courses in many areas of Applied Math for a growing private university. He then gained experience leading and coordinating support teams and software engineering projects for five years at the largest EMR provider in the US. He applies his research, teaching, leading, and implementing skills as the first Data Scientist at Open iT, where he is the owner and lead developer for the LicensePredictor module released in April 2019. Tom's passion is to understand how iT can better manage software licenses and other assets and apply the latest big data and machine learning solutions in as lean and usable manner as possible.

Presenter Name: Semler, Christian

Presenter Company: MAYA HTT

Presentation Title: Development of a Real-time Engine Temperature Monitoring System, Using AI Based on Accurate and Validated Thermal Simulation Data

Session Title: 2B Artificial Intelligence & Machine Learning

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:50 PM

Keywords: Artificial Intelligence, AI, thermal, simulation, virtual sensor

Abstract:

In the context of global warming, highly competitive markets, and usage of multiple sources of energy, it becomes more and more important to optimize the operation of gas turbine power plants. This means that starts and stops of these engines become more and more frequent. On the other hand, engine manufacturers provide the operators conservative guidelines on how long to let the engine cool down before starting a new cycle, to ensure temperatures do not exceed certain thresholds. While stationary components of the engine can be monitored easily, it is very difficult and expensive, if not impossible, to monitor the temperature of some rotating parts which determine the engine conditions (cold / warm / hot). These temperatures are critical to predict clearances, and have a potentially significant impact on the life span of the engine. The goal of this paper is to present an approach for real-time monitoring of these internal temperatures using AI, based on accurate and validated simulation data. More specifically: a) Siemens Simcenter 3D Thermal is used to build a complete representation of the whole engine through the use of thousands of separate boundary conditions that adequately represent the transient behavior of the whole engine. These boundary conditions represent the flow conditions, in various regimes, for a range of rotational speeds and in different sections of the engine. They make use of built-in thermal correlations, of â€œexpressionsâ€� that can automatically access specific model data (e.g., fluid temperature, material properties, solve-time computed results, rotational speed or radius), or of proprietary correlations obtained from in-house measurements, experience or CFD. b) This â€œdigital twinâ€� is validated against experimental data where scaling factors on the boundary conditions are used to obtain very precise thermal predictions. c) â€œVirtual sensorsâ€� are created at specific locations that need to be monitored in real-time during operations and that cannot be instrumented easily. d) Machine learning (ML) algorithms and reduced order techniques are used to correlate the temperature time-response of these virtual sensors against real physical sensors where temperature can be easily monitored. Since the response is encapsulated in a much reduced set, it runs very fast compared to the digital twin. e) The time response of the virtual sensors could then be implemented â€œon the edgeâ€� in a real-time data acquisition system that instruments the engine. The advantage of the method is that it is general enough to quickly create engine-specific virtual sensors while taking into account all of the specific physical characteristics of the engine (fluid temperatures, mass flow rates, engine operating conditions, thermal inertia, etc.). This method will be illustrated on a real engine for demonstration purposes.

Speaker Biography:

Not Provided

Presenter Name: Draup, Jefri

Presenter Company: EDF Energy

Presentation Title: Model reduction and uncertainty quantification for weld simulations on ferritic materials

Session Title: 2D Uncertainty Quantification 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:50 PM

Keywords: welding; phase transformations; model reduction; uncertainty quantification; FE; non linear; materials;

Abstract:

Weld residual stresses play an important role in structural integrity assessments of engineering structures. In paricular, they can reduce both the fatigue life of structures containing defects and increase the propensity of these structures to brittle failure. In a safety concious industry such as nuclear, the use of conservative assessment methodologies with residual stresses can lead to difficulties in justifying continued safe operations of aging infrastructure. Hence, the ability to quantify weld residual stresses both accurately and reliably can be important in ensuring the economic sustainability of engineering assets. For some common materials, such as ferritic steels, the metallurgical behaviour has a direct relation on the residual stresses generated during welding. Finite element based computational methods have been shown to be able to accurately predict the quantity of residual stresses even for ferritic steels. It must be noted that these methods rely on accurate metallurgical models capturing sold state phase transformations. Further, these methods rely on many input quantities that are subject to sources of measurement uncertainty, such as alloy chemical composition. Thus, the reliability of predictions is not easily quantifiable, particularly because computational methods are expensive and time consuming to deploy. In this study, a method for accurate model reduction of weld simulations, based on proper orthagonal decomposition and Gaussian process regression is demonstrated. The model reduction technique is used to enable a systematic uncertainty quantification study on weld residual stress models. Specifically, the sensitivity of residual stresses to the natural variation in material properties of ferritic steels is evaluated. Sensitivity is quantified from Sobol indices based on the Saltelli algorithm. The study implies that state-of-the art residual stress prediction methods can be applied to ferritic welds with confidence. Furthermore, the use of statistical techniques using open source toolkits, such as openTURNS, demonstrates that powerful uncertainty quantification techniques can be deployed to support structural integrity assessments of welded structures at low cost to business. Such tools can be used to accelerate the acceptance of methods that have been hitherto limited to research and development.

Speaker Biography:

Not Provided

Presenter Name: Neumann, Johannes

Presenter Company: Rafinex Ltd.

Presentation Title: Stochastic Topology Optimization For Robust And Reusable Designs

Session Title: 2D Uncertainty Quantification 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:00 PM

Keywords: Robust Design, Uncertainty Quantification, Confidence in Results, Probabilistic Analysis, topology optimization

Abstract:

Modern production methods, such as 3D printing, can manufacture almost constraint free form variations. Topology optimization enables engineers to explore the vastly increased design possibilities. Given the performance requirements, a part is optimized to be as cheap or lightweight as possible. Provided with the greatest allowed extent of the part, the algorithm fully controls the shape and placement of material and the incorporation of holes. Care needs to be taken as there is a high risk of over-optimization towards the provided load cases. As a result the part might perform well in the simulated environment but fail in the actual application as unforeseen load conditions might occur or load cases might deviate due to some margin of error in manufacturing and application. Stochastic topology optimization yields reliable optimal forms by extending physics models with risk assessment approaches from financial mathematics using formal uncertainty quantification methods. Loads are allowed to have an error in direction or magnitude, materials might have production faults. Incorporating these defects in the optimization yields unique designs that are not achievable by conventional topology optimization. The generated designs react much more robustly to changing and unknown conditions in the physical world and have greatly increased reusability potential thanks to a greater performance envelope while maintaining or reducing weight compared to conventional design methods. Manufacturability can be ensured with additional constraints such as two mold casting or printability for different printing techniques. State of the art adaptive numerical algorithms ensure high resolution, high quality ready to manufacture designs. These can be used to rapidly design and manufacture performance parts or as a blueprint for a more traditional design approach. The degree of robustness can be controlled on a high level with model parameters when employing the Bayesian approach or on a low level frequentist approach by prescribing probabilities and a desired risk measure for more control and even more optimization potential.

Speaker Biography:

Johannes Neumann started his scientific career with a Diploma in mathematics from the Humboldt University Berlin. He wrote his doctorate thesis at the Weierstrass Institute about partial differential equations with stochastic input data. He then continued to work in the field of robust topology optimisation which formed the basis for Rafinex. He founded the company in Luxembourg together with engineers from Imperial College. Since then, he improved the quality and speed of these algorithms and conceived various solutions for a varied field of engineering challenges as the head of research at Rafinex.

Presenter Name: Patelli, Edoardo

Presenter Company: Strathclyde University

Presentation Title: Dealiong with uncertainty with confidence

Session Title: 2D Uncertainty Quantification 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 2:25 PM

Keywords: Uncertaity quantification, simulation, confidence level, sensitivity

Abstract:

In modern engineering systems uncertainty quantification must be performed to assure an adequate level of safety and reliability. Sources of uncertainty can be the inherent variability of physical quantities or events, adoption of approximate models, missing or insufficient data, and lack of knowledge. Especially for cases affected by a lack of data, where imprecise information or expert judgement is utilised, and there is a poor understanding of all the relevant underlying process, strong initial assumptions may be needed to use classical probabilistic methods. However, these assumptions can deeply influence the final results and lead to severe risk misjudgement. Assessing the effect of uncertainty and accounting for individual contribution on the quantity of interest requires not only the adoption of efficient simulation methods but also the cabability to provide some level of condidence to the analysis. The first problem is addressed with the use of advanced Monte Carlo methods aim at estimating rare failure probabilities more efficiently than direct Monte Carlo. The latter is provided by adopting imprecise probability and representing the uncertainties using interval or probabilistic boxes. However, the proper propagation of such representation of uncertainty furthrer increases the computational cost of the analyis. To solve this problem, we present methods to robustly propagate probability boxes through expensive black box models, with a reliability assessment of the propagation of the epistemic uncertainty. We obtain a distribution free probability box for the output of the model, or alternatively an interval for the failure probability. Our algorithms are sampling based, and so can be easily parallelised, and make no assumptions about the functional form of the model. In the first of two proposed algorithms we describe an approach to construct a metamodel for the probability box of the system response directly. Our proposed methods are flexible and efficient and they are inplemented into a open source general porpose software for uncertainty quantification named OpenCossan.

Speaker Biography:

Not Provided

Presenter Name: Reijmers, Jack

Presenter Company: Nevesbu

Presentation Title: Uncertainty in simulation and test

Session Title: 2D Uncertainty Quantification 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 3:15 PM

Keywords: Stochastics, Uncertainty, Finite Element Analysis, Experiment

Abstract:

Uncertainty is responsible for the difference between numerical simulation en experimental data. In most cases the differences can be pinpointed to modeling errors. Round robins are a nice example of uncertainty in numerical simulation. Participants are requested to predict an experimental outcome, while this outcome is withheld. In the end the findings of the participants are presented in combination with the result of the experiment. The differences can be large. There are epistemic and aleatory uncertainties and the errors in instrumentation are typically of the second kind. A lot of testing will improve the accuracy and lower the error to order of 1%. On the other hand, epistemic uncertainty represents a lack of knowledge. The easy way out is to capture this deficiency in a statistical distribution with a mean value and a standard deviation. However, further study may fill the knowledge gap and the cause of this uncertainty can be eliminated. It is very tempting to focus on the way of modeling. Finite Element Analysis (FEA) offers an extensive toolkit to simulate the experiment under consideration. The application of linear versus quadratic elements may have a large effect on the outcome, and not in the least, mesh size plays an important role. However, the results from the experiment are in most cases considered as a reference that represents the exact value. The presentation addresses an experiment with a U-shaped plate. The legs are pulled apart, and strain gauges indicate the stresses in areas with unidirectional as well as biaxial stress states. The accuracy of the measurement is an important aspect of this experiment, and especially the measurement of principal stresses at locations with a biaxial stress state draws attention. Rosettes initially measure changes in electrical resistance, and these changes are translated to strains. The next step is processing the results towards principal directions and from the strains follow principal stresses by constitutive equations. With each step in the process intrinsic errors (aleatory uncertainty) in measurement and material property accumulates. The experiment is also simulated with FEA, and the influence of mesh refinement and element type is assessed. The variation in modeling gives confidence in the numerical result and relays the focus on the accuracy of the experiment. Besides the intrinsic error of the instrumentation the location of the measurements is important. Rosettes consist of three strain gauges, rotated over 45Â°, and this means that strains are not measured on exact the same spot. A closer look at the location of the three components of the rosette highlights the (epistemic) uncertainty in the measured strains. The presentation focuses on the difference between test and simulation and assesses the underlying aspects.

Speaker Biography:

Jack Reijmers is a retired naval architect. He graduated from the Delft University of Technology in 1982 and started his career at Nevesbu B.V. in The Netherlands. In the eighties of the last century his activities comprised naval projects with a special focus on submarines, such as the Walrus and Sea dragon class. In the years ninety, activities shifted to offshore engineering, however with strong involvement in submarine engineering (the Moray class). In the beginning of this century he worked for seven and a half years as a consultant for Navantia at the Cartagena Shipyard in Spain, assisting in submarine engineering. In 2015 he joined the Stochastics Working Group, and at the World Congress 2019 in Quebec he was awarded the status of NAFEMS Technical Fellow. Although retired he is still active, not in the least by a PhD study on pressure hull analysis on a reliability basis.

Presenter Name: Monti, Tamara

Presenter Company: Dassault Systemes UK Ltd

Presentation Title: Motor design optimization including electromagnetic performance and mechanical stress

Session Title: 3A Electromagnetics

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 3:55 PM

Keywords: Multiphysics, optimization, electromagnetics, automotive, synchronous motor, 3DEXPERIENCE

Abstract:

The challenges in designing drive units for vehicle traction applications are inherently multiphysical. In particular, the interplay between mechanical, thermal and electromagnetic requirements as well as lubrication and noise emission have to be taken into account. Obvious goals for electrical machines used in electrical and hybrid vehicles are reasonable power, high power-to-weight ratio, good efficiency and low cost. However, numerous constraints, including mechanical stiffness, thermal and noise emission levels as well as a required durability, are limiting factors. Therefore, a design space exploration/optimization including proper constraints has to be performed to obtain a machine design fulfilling all requirements. Since the design space is typically quite large, performing all analyses in the individual domains for each parameter combination is not feasible due to the huge computational cost. The proposed approach splits the optimization into successive phases. In the first phase the large design space is considerably reduced by an optimization including just a subset of the analyses with short execution times per design point. In the second phase the more time consuming analyses are performed on just a few â€œhotâ€� candidates to investigate whether the residual constraints in the other domains are fulfilled. During the first phase the two dimensional motor geometry is optimized by performing both an electromagnetic steady-state analysis using sinusoidal currents and a mechanical stress analysis to check the design against mechanical stiffness constraints. The electromagnetic analysis part consists of simulating (i) the behaviour over the operating range, (ii) loss and efficiency at selected operating points and (iii) demagnetization under worst-case fault condition. The second optimization phase consists of loss and force calculation using inverter fed currents, which are transferred to subsequent thermal as well as noise and vibration calculations. In case the requirements are not fulfilled, the design has to be adjusted either by improving the cooling system or improving the stiffness of the motor housing. If a viable solution is not found the electromagnetic design must be revisited, using tighter constraints for the optimization. In order to seamlessly analyze the different aspects of the drive unit design, a parameterized model has been built using CATIA on the 3DEXPERIENCE platform. In this way the two dimensional FEM simulation models used in both the electromagnetic and in the mechanical domains, which require different levels of fidelity, are efficiently derived from one underlying parameterized 3D CAD geometry. In this work an optimization of an interior permanent magnet synchronous machine (IPMSM) with 8 magnet poles, 48 slots, a distributed winding with 8 turns and NdFeB magnets has been performed.

Speaker Biography:

Tamara Monti is an Industry Process Consultant for SIMULIA, the simulation brand of Dassault Systèmes. She earned the PhD degree in Electromagnetics in 2013. She has been visiting researchers at the Trieste Synchrotron, at Temple University of Philadelphia and at the University of Maryland at College Park working on microwave nanotechnology. She has held a postdoctoral position at the University of Nottingham from 2014 to 2017 on high power microwave material processing. In 2017, she joined CST, subsequently acquired by Dassault Systèmes, where she is currently one of the computational electromagnetic experts, in particular for the transportation and mobility customers.

Presenter Name: Palumbo, Nunzio

Presenter Company: Rolls-Royce Group PLC

Presentation Title: 3D Electromagnetic Eddy-Current problems within the Finite Element Framework of computing platform FEniCS.

Session Title: 3A Electromagnetics

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 4:20 PM

Keywords: Finite Element, Electromagnetism, HPC, FEniCS

Abstract:

Nunzio Palumbo, Sandeep Shrivastava, Neeraj Cherukunnath, James McDonagh, Suvro Mukherjee, Ed Green Rolls-Royce plc. PO Box 31, Derby, DE24 8BJ, United Kingdom Mail code: ML80, B3, Derby Moor Lane M +44 (0)7825124217 | T +44 (0)1332 2 44342 Nunzio.Palumbo@Rolls-Royce.com T +44 (0)1332 2 49275 Neeraj.Cherukunnath@Rolls-Royce.com M +44 (0) 7887 533181 | T +44 (0)1332 2 69179 Ed.Green@Rolls-Royce.com Aerospace industry is driving more electric solutions to support aviation sustainability. As part of the journey towards electrification, industry needs large scale fast and efficient coupled multi-physics simulations. High Performance Computing (HPC) along with iterative solution schemes offer means of achieving this. Under the EPSRC funded ASiMoV project, Rolls Royce plc is working with a number of partners to develop a coupled electro-thermo-mechanical simulation capability for large scale engineering systems. Electromagnetic phenomena are most commonly formulated and solved using the finite element method (FEM). Based on the operating frequency, electric machine problems can be categorized into eddy current and magnetostatic. Here, 3D electromagnetic eddy-current problems are investigated within the finite element framework of computing platform FEniCS. Simulation speed is addressed by the use of parallel iterative sparse solvers in a High Performance Computing environment. The numerical procedure involves solving the time harmonic Maxwell's equations by means of the Coulomb gauged magnetic vector potential A and the electric scalar potential V (known as the A-V formulation). The numerical method as well as the implementation within FEniCS is described. The weak formulation derived in FEniCS for the integration of the Maxwell's equations is also presented. After briefly presenting the numerical procedure, this paper will focus on the models that have been implemented using FEniCS open-source computing platform. A brief description of the models will be given as well as the main results obtained. For each test case, some results, especially current density and magnetic flux density predictions at different frequencies have been extracted and qualitatively compared to the associated reference model that is implemented using commercial off the shelf software (e.g. OPERA 3D - Simulia by Dassault SystemesÂ®). In the future new features will be implemented and further cases implemented to cover wider aspects of electromagnetic modelling and addressing parallel scalability in HPC systems.

Speaker Biography:

Nunzio joined Rolls-Royce in 2011 after completing a PhD in Mechanical Engineering at the University of Exeter. As part of his role in the Engineering and Technology function, he has been developing and implementing physics-based modelling and simulation tools and leading research and technology development projects. In 2018 moved to the Innovation Hub department in the Future Methods Team, where he focuses on development of innovative and radical modelling and simulation tools to support Rolls Royce electrification strategy. He is a Chartered professional Engineer of the Institution of Mechanical Engineers (UK).

Presenter Name: Prakhya, Ganga Kasi

Presenter Company: Sir Robert McAlpine Ltd

Presentation Title: Innovation through simulation in Built Environment

Session Title: 3B Infrastructure

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 3:55 PM

Keywords: Finiet Element Analysis, Soil structure Interaction

Abstract:

This paper summarises a novel method of using technology for optimisation with respect to cost and programme in a major redevelopment Built Environment Project at Woking, UK. The scheme will provide a 190-bed hotel, circa 11,000m2 of retail space, 450 apartments in two 34-storey apartment blocks, a medical centre, energy centre and multi-storey car park. The project also involves alterations to highways and infrastructure works and extensive public realm works, including a space-frame glazed canopy over an external shopping mall. Initial models developed in RIVET were used to compute the loads on foundations at very early stages of the project when the contractors, Sir Robert McAlpine (SRM), were involved on the project. The geology of the site consisted made ground and followed by sand/silt/clay mixture and with an unusual combination of the particle size distribution, The stiffness of the ground appeared to be very high but due to the sand content in the mix, it was initially thought the mixture might offer less resistance and hence may cause excessive settlements to the structures. At Woking, No buildings of such height have been considered on these types of soils. The Engineer original proposal was to have a deep piled foundations extending at least 50m with bored piles of 1200mm diameter into stiffer lower strata to transfer the building loads. SRM proposed additional testing to determine the strength of the upper strata in order to propose a hybrid foundation for the buildings. Working collaboratively with the project Engineer on the project, the finite element models are used in the next stage of design to optimise the foundation using soil structure interaction analysis. Analysis was verified with the observations on site and is supplemented with additional site testing of soil. The detailed finite element models developed were used for designing reinforcement to Eurocodes.

Speaker Biography:

Not Provided

Presenter Name: Teixeira, Ricardo

Presenter Company: Mott MacDonald

Presentation Title: Innovative Techniques for Bridge Assessment

Session Title: 3B Infrastructure

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 4:20 PM

Keywords: finite element modelling, numerical modelling, live strain monitoring, natural frequency analysis, acceleration data

Abstract:

The topic of bridge assessment has taken particular relevance on the later part of the 20th Century when the advancements in the knowledge of reinforced concrete behaviour made the structural engineering community aware of the fact reinforced concrete and pre-stressed structures designed and built in the 1960's were unlikely to last the 100 years they had been designed to. The United Kingdom, with most of its motorway network having been built during the 1960s, is a typical example of this. This paper focus on the inspection, structural assessment and load monitoring that Mott Macdonald's A3M (Advanced Analysis for Asset Management) team was commissioned to undertake on this rather unique reinforced concrete arch bridge with a total span of circa 50m, built in 1968. This arch bridge, located in an area of outstanding natural beauty in South Wales and presently owned and managed by a Water Company. The first part of the paper explores the numerical analysis techniques employed, such as 3D model build and the live strain monitoring of a 96T moving crane that was undertaken using a system of wireless strain gauges is covered in detail. Alongside this, the approach and development of an in-house finite element package, developed by one of the authors, to visualise and validate results from a commercial package is discussed. The second part of the paper focus on the aspects related to the static and dynamic modelling of the structural behaviour of the bridge using the finite element method. Some of the techniques developed by the authors to establish comparisons between the experimental and numerical results are explored, with an approach to calibrating complex 3D models with experimental acceleration data recorded using smartphones located in key areas of dynamic response. The paper finishes with a summary of the fundamental conclusions of the use of acceleration and strain data and their use as validation tools in understanding more about historic structuresâ€™ condition and response to modern day loading.

Speaker Biography:

Not Provided

Presenter Name: Seshadri, Pranay

Presenter Company: The Alan Turing Institute

Presentation Title: Effective Quadratures: Empowering Engineers with Open Source Computational Methodologies

Session Title: 3E Uncertainty Quantification 2

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 3:55 PM

Keywords: uncertainty quantification, machine learning, optimisation, dimension reduction

Abstract:

Todayâ€™s engineer is tasked with a myriad of different computational tasks for which they turn to a variety of proprietary and open-source computational tools. These tasks include design optimisation, uncertainty quantification and statistical inference. For the open-source codes, the onus of understanding the computational methodology resides wholly with the engineer, while for proprietary codes, the onus is on the software vendor to elucidate their techniques. Within todayâ€™s rapidly evolving ecosystemâ€”owing to the rise of machine learningâ€”itâ€™s not surprising that companies are increasingly gravitated towards open-source tools as they are better reflective of the state-of-the-art. However, these codes need to have better documentation, appropriate version control mechanisms, and avenues for educating engineers to be truly transformative in the computational simulation sector. Effective Quadratures aims to do precisely this. Effective Quadratures is an open-source library for uncertainty quantification, machine learning, optimisation, numerical integration and dimension reduction â€“ all using orthogonal polynomials. It is particularly useful for models / problems where output quantities of interest are smooth and continuous; to this extent it has found widespread applications in computational engineering models (finite elements, computational fluid dynamics, etc). It is built on the latest research within these areas and has both deterministic and randomized algorithms. Unlike existing open-source tools built on neural networks, Effective Quadratures is built by projecting polynomials and splines over subspaces â€”ensuring efficacious use of black-box model evaluations. Effective Quadratures is actively being developed by researchers at the University of Cambridge, Imperial College London, Stanford University, The University of Utah, The Alan Turing Institute and the University of Cagliari. In this presentation, I will talk about some of the underlying methodologies in the code and show how easy it is to use the underlying subroutines: within just a few lines of code, users can build sophisticated models, optimise complex functions and get statistical summaries of their problem. I will wrap up with pertinent industrial case studies.

Speaker Biography:

Pranay Seshadri is the Group Leader in Aeronautics, within the Data-Centric Engineering Programme at the Alan Turing Institute. He is also a Research Fellow in the Department of Mathematics at Imperial College London. He is also the Founder and Lead Mathematician for the open-source Effective Quadratures, which will be the focus of his talk.

Presenter Name: Stodieck, Olivia

Presenter Company: Daptablade LTD

Presentation Title: Supporting the Design of Composite Components using Multi-physics Simulations

Session Title: 3E Uncertainty Quantification 2

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 4:20 PM

Keywords: Model validation, uncertainty, multi-disciplinary analysis

Abstract:

MASCoTS will commercialise a novel composites technology, which allows the placement of carbon tapes along curved paths (fibre steering). Fibre steering drastically increases the structural performance of composites and can contribute significantly towards the targets set by the ATI on efficiency of aerostructures. The consortium focuses on Continuous Tow Shearing, the world's first automated deposition technology that can fibre-steer without defects. The aims are to optimise the existing machine for speed and reliability and develop the necessary design and analysis tools for the commercial use of the process, making the UK a pioneer in the novel field of fibre steering.

Speaker Biography:

Dr Olivia Stodieck graduated from Imperial College London in 2007 with a First Class Masters degree in Aeronautical engineering. She subsequently moved to Bristol, working for Airbus UK in the structures analysis department and working on a number of aircraft programmes, including A400M, A350 and A380. She was awarded a full time CASE PhD sponsorship at the University of Bristol in 2012, on the topic of tow-steered composite wing aeroelastic tailoring. After graduating in 2016, she continued to work as a research associate in Aerospace Engineering at the University of Bristol, contributing to the Airbus sponsored Agile Wing Integration project and investigating novel methods for wing analysis and design.

Presenter Name: Butler, Celia

Presenter Company: Synopsys (N.E) Ltd

Presentation Title: Rapid 3D Inspection of AM Components Using CT: From Defect Detection to Thermal Performance Simulation

Session Title: 4A Additive Manufacturing

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 10:35 AM

Keywords: Additive manufacturing, image-based modelling, image-based simulation, CT

Abstract:

Metal Additive Manufacturing (AM) can be used to produce topologically complex designs, which are difficult or impossible to engineer using traditional manufacturing techniques. Non-destructive inspection and testing of such structures can be challenging due to internal or inaccessible features. Inability to find and correct for defects in built parts can lead to increased performance testing, potentially more failures and therefore more scrappage of parts; wasting precious time and resources. Here a â€œhot boxâ€� heat exchanger is presented as an industrial example of how X-ray Computer Tomography (CT) can be used as part of a non-destructive testing process to inspect complex structures. From the CT scan, an image-based model was be built to identify and analyse defects and deviations from the original design. At this stage the part could be deemed fit for use if any deviations fall within allowed tolerances or inspected further using image-based simulation. Inspection at this stage also means changes can be made to the manufacturing process for future manufacturing runs (such as a design change for trapped powder extraction). Image-based simulation allows virtual performance testing of the â€œrealâ€� part (as opposed to a CAD idealisation). This includes any defects, pores, warping etc. which could have occurred during the manufacturing process. In the â€œhot boxâ€� heat exchanger example, defects in the structure were identified. This was mainly in the form of trapped powder in narrow channels, and some deviation to the lattice structure. An image-based simulation of the â€œas-builtâ€� structure was undertaken to show the impact of these deviations from the â€œas-designedâ€� structure. This simulation focuses on the thermal performance of key areas of the â€œhot boxâ€�. The ability to perform dimensional, integrity and surface inspection in a single workflow proved to be highly beneficial for the current production process of the â€œhot boxâ€�. It has the potential to reduce inspection time and remove the need for additional inspection equipment, therefore reducing costs, cycle times and potential increasing workable floorspace.

Speaker Biography:

Senior Applications Engineer for Synopsys & University of Exeter Honorary Senior Lecturer for University of Exeter Over 10 years experience leading research projects and product development in commercial and academic teams Works closely with engineers and reserachers Generating high quality models Used to solvce complex problems from a wide range of industries

Presenter Name: Lauterbach, Beate

Presenter Company: Volume Graphics GmbH

Presentation Title: Structural simulation of components with defects - a workflow from Computed Tomography to Finite Element Simulation

Session Title: 4A Additive Manufacturing

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 11:00 AM

Keywords: computed tomography, porosity, casting, additive manufacturing; microstructural simulation, immersed boundary methods

Abstract:

Deviations between the designed and the manufactured part can be identified by means of non-destructive inspection methods, e.g. computed tomography (CT). Beside major geometrical differences like shrinkage and distortion, surface and internal defects become visible. As in general defects are sources of stress concentration, it is important to evaluate their impact on the structural performance of a component. Thus, including microdefects into a structural mechanics simulation would be desirable. Building a Finite Element Model that includes a huge amount of microstructural defects will create an enormous effort in FE mesh generation. To resolve stress concentrations in the vicinity of each defect, fine discretization is necessary. This will result in very large simulation models that can hardly be handled. The simulation effort can be reduced significantly including only the critical defects that will affect the structural performance in the FEM simulation. By using a specific finite element variant, a so called immersed-boundary solver, an accurate pre-simulation including all detected pores can be done easily. These immersed-boundary methods do not require a geometry conforming mesh but operate directly on the image data, which is a big advantage for simulation of components with very complex geometrical features. This approach is implemented in the Structural Mechanics Simulation module of VGSTUDIO MAX by Volume Graphics. It simulates local stress distributions for linear elastic material properties directly on computed tomography (CT) scans which accurately represent complex material structures and internal discontinuities. From the stress fields calculated by the immersed boundary finite element simulation, the microstructural defects can be sorted with respect to their severity and thus critical pores can be identified. This reduction of geometrical complexity makes a classical FEM simulation feasible which allows the use of the wide range of functionalities that are offered by a fully capable finite element software (e.g. non-linear material models). The volume meshing module in VGSTUDIO MAX enables efficient creation of a tetrahedral mesh on the CT scan and therefore bridges the gap between image data and classical FEM simulation. A workflow from CT scanning, analyzing most critical defects and efficient meshing to nonlinear structural simulation with ANSYS maintaining the relevant features of the scanned object will be presented. It enables to assess the mechanical performance of the manufactured part.

Speaker Biography:

Volume Graphics GmbH 2001 PhD from TU Darmstadt, Institute for Mechanics 2001-2004 Simulation Engineer for Fatigue at Ford Werke, Cologne, Germany 2004-2016 CAE Development Engineer Vehicle Safety at Opel Automobile GmbH, Ruesselsheim, Germany 2016-2019 Supervisor Crashworthiness CAE at Opel Automobile GmbH, Ruesselsheim, Germany Since 2019 Volume Graphics GmbH, Produktmanager and Product Owner Simulation: Software Developement for simulation on CT data

Presenter Name: Ashton, Neil

Presenter Company: Amazon Web Services

Presentation Title: High-Fidelity CFD for the Automotive and Motorsport Sectors in the Cloud

Session Title: 4B CFD 1

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 10:35 AM

Keywords:

Abstract:

Speaker Biography:

Not Provided

Presenter Name: Cherukunnath, Neeraj

Presenter Company: Rolls-Royce Group PLC

Presentation Title: Novel Multi-billion Degrees-of-freedom FEA Models for Rapid Simulation of the Multi-physics Behaviour of a Complete Aero Engine

Session Title: 4B CFD 1

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 11:00 AM

Keywords: Thermo-Mechanical, Finite Element, HPC, Iterative Solver

Abstract:

Simulation and modelling, enabled by high performance computing, have transformed the way aero-engines are designed and engineered. However, next generation engines will place demands on simulation that cannot be met by incremental changes to current techniques. There is a strong industry need to deliver efficient engines to the aerospace market in significantly reduced timescales, but with a much higher level of maturity. High Performance Computing (HPC) offers a means of achieving this by providing fast, accurate, simulation of operational behaviour at all stages of a products lifecycle. This includes the accurate prediction of blade tip and seal clearances using very large, high fidelity, coupled thermo-mechanical models at whole engine level. Under the EPSRC funded ASiMoV project, Rolls Royce Plc is working with a number of academic and industrial partners, to develop an advanced, large scale multi-physics simulation system capable of running multi-billion DoF models on HPC systems. This paper describes the complex process of model generation, meshing, application of complex boundary conditions and creation of complex flight profiles at whole engine level. The paper also covers the development of a Message Passing Interface (MPI) based distributed parallel iterative finite element solver, implemented on the public domain FEniCS code and an in-house finite element system. The three benchmarks under consideration are a large component model, a whole engine level static structure model and finally a large high fidelity model that is a close representation of a production aero engine. The largest model consists of six thousand components with complex thermal boundary conditions, structural constraints and loads. The loading conditions are representative of complex flight cycles. Multi-billion element meshes have been generated with advanced mesh generation processes. This results in the generation of large finite element binary input data for these models. To handle the large amounts of input data, mesh related data has been separated from data related to boundary conditions and loadings, which are linked to the external geometry. These geometry faces are tagged to finite element faces and this information is stored in an HDF5 formatted mesh file. The major challenge in developing scalable speed and accuracy is the development of solver technology, particularly iterative solvers for implicit coupled thermo-mechanical finite element analysis. After briefly presenting the algorithmic aspects of the solver, this paper will focus on the performance aspects of the benchmark models under various solver parameters and pre-conditioners. In order to improve the scalability of the solver, codes are parallelised throughout the analysis, from reading input HDF5 files to writing results data after the parallel iterative solve. The input mesh data on multiple MPI processes have been partitioned using parallel partitioning algorithms and distributed to multiple processes. In the transient time stepping process, parts of large linear system are assembled from evaluated element matrices in corresponding MPI processes and solved using a pre-conditioned iterative solver. The iterative solution process is based on the efficient usage of the public domain Portable, Extensible Toolkit for Scientic Computation (PETSc) and related codes. For each test case, the results, especially deflections, are compared between the in-house system and the FEniCS code. In the future, the focus will be to develop an advanced process to build large whole engine models representing better physics, faster generation of large meshes and implementation of advanced algorithms to improve parallel scalability in solution process in HPC systems.

Speaker Biography:

Neeraj Cherukunnath is a Technical Specialist of Computational Engineering in Central Technology Group of Innovation Hub in Roll-Royce Plc. He holds a PhD in Computational Engineering from University of Southampton and joined Rolls-Royce in 2004. He has several years of experience in developing numerical methods and in the development of in-house thermo-mechanical Finite Element Code. He has previously collaborated in research activities with Rolls-Royce University Technology Centres in the field of Computational Mechanics. He is currently leading research and development activities of a Work Package in ASiMoV, an

EPSRC Prosperity Partnership project, in collaboration with other academic partners. He is also a chartered engineer and a fellow of Institute of Mechanical Engineers.

Presenter Name: Bligh, Amanda

Presenter Company: aPriori Technologies

Presentation Title: Understanding the Manufacturing Cost Drivers of Tolerances

Session Title: 5A Manufacturing Process

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:05 PM

Keywords: cost, manufacturing, democratization, cost simulation

Abstract:

Appropriate tolerancing is a critical component of reaching the best manufacturing cost for a component, with tight tolerancing being a common reason for the selection of more expensive manufacturing processes. During a standard design and development process, it is generally difficult for an engineer to understand the impact of tightening or loosing tolerances on manufacturing process selection and the resulting manufacturing cost. This is especially true for newer engineers or those with limited experience in manufacturing. Ideally, an engineer with limited manufacturing experience would be able to investigate an extensive list of manufacturing and tolerances combinations and receive feedback on the cost from internal experts or suppliers to help build their intuition. Completing this process, though, is time prohibitive and requires the involvement of many individuals. Automation of this process using available software tools would be a natural solution. A geometry-based manufacturing and costing analysis solution which can read PMI based tolerances and includes common heuristics for manufacturing process selection can provide visibility to the impacts of tolerances on manufacturing process selection, cycle time, and cost more quickly and consistently than consulting an expert. By automating such a software with a multi-discipline design optimization toolset, it now becomes feasible to understand the impacts of tolerance changes on manufacturing process requirements and find better solutions for both tolerancing and manufacturing options. In this study, tolerance and manufacturing options are investigated for a manufactured part through the automation of the aPriori costing software using a multi-disciplinary design optimization toolset. With this investigation it is possible to see opportunities for manufacturing improvement by using cost as the primary metric. Additionally, the output of such an analysis enables those with limited experience in manufacturing to make informed decisions regarding the manufacturing implications of tolerancing, thus providing an opportunity to further democratize aspects of the engineering process.

Speaker Biography:

Amanda Bligh has been with aPriori for over a decade and is currently focusing on advanced capabilities research and helping customers with advanced solutions to manufacturing costing questions. During her time at aPriori, she has built numerous manufacturing cost models, worked with a wide selection of customers both in the US and Europe and been heavily engaged in understanding customers' needs and use cases. Recent work has included working with customers to fit cost into their MDO workflows and understanding the cost break points for additive versus traditional manufacturing. She completed her BS at MIT in mechanical engineering and her MS and PhD at the University of Rhode Island in manufacturing and systems engineering, focusing her research on improving tools within the product development process and displaying sustainability metrics during the design process. She has taught Design for Manufacture both at aPriori and at the university level, and has a strong interest in engineering decision-making frameworks. Prior to working at aPriori, Amanda worked for Hasbro on its Nerf and SuperSoaker toy lines and received three patents on toy design. In her free time, Amanda enjoys mountain biking, indoor rock climbing and reading.

Presenter Name: Cueto Carrion, Melodie

Presenter Company: National Composites Centre

Presentation Title: Finite Element Simulation of the Braiding Process

Session Title: 5A Manufacturing Process

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 11:40 AM

Keywords: Braiding, Process Modelling, Finite Element Analysis (FEA)

Abstract:

Braiding is a direct tow to net-shape preform technology enabling to tailor performance with braid angle variation, different interlacing patterns and possibility of triaxial structures. This design flexibility also comes with high production rate and repeatability, making braiding extremely suitable to fully automated processes. With ever stricter environmental regulations, the demand for composites parts has been increasing significantly over the last decade. As a result, finalising the transition to highly automated processes has never been more pressing for the composite manufacturing industry. The scarcity of reliable process modelling leads to costly and time-consuming physical trials, slowing down the adoption of the technology. Accurately predicting the preform fibre architecture allows to understand the mechanical properties of the finished part, but also to anticipate defects arising during the braiding process and at the resin infusion stage. Hence, this work is focused on producing a model that predicts accurately the fibre architecture of a braided preform. A previous study conducted by the National Composites Centre (NCC) [1] compared the kinematic and Finite Element (FE) output for a given shape and confirmed that considering the yarn-to-yarn and yarn-to-mandrel friction produces a more accurate representation of the braid architecture. This was achieved by using an in-house developed FE model in Abaqus, and follow-up activity has focused on increasing the capacity and quality of such model. This paper aims to outline the advances made in the modelling of the braiding process using the finite element approach and discuss some of the most challenging aspects. By developing more in-depth verification and automation methods, the following areas of improvement were identified: contact modelling between the yarns, the yarn tensioning system, and braid pattern irregularity. These issues were addressed in the model and validated against an experimental trial using an in-process monitoring of braid angles. The outcome was an improved prediction of the braid angle, an even pattern and a more lightweight and efficient model. The resulting model can now be the starting point for further simulation, to predict the permeability and structural integrity of the future manufactured part. References: [1] A. Treviso, L. Thadhani, D. Ivanov, L. Kawashita, XC. Sun, Braiding process simulation: comparison of kinematic and finite element models for large scale components, NAFEMS World Congress 2019 [conference paper]

Speaker Biography:

Not Provided

Presenter Name: Cueto Carrion, Melodie

Presenter Company: National Composites Centre

Presentation Title: Manufacturing Process Chain Model in Composites Manufacturing

Session Title: 5A Manufacturing Process

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:55 PM

Keywords: Manufacturing Process Model, Polymer matrix composites (PMCs), Cure Simulation, Compaction, Automated Fibre Placement (AFP)

Abstract:

Over the last decades, Automated Fibre Placement (AFP) has been gaining popularity within the aerospace, automotive and renewal energy industries and has been progressively replacing hand layup [1]. This technology allows for higher production rates, however there are still several defects arising during the manufacturing process that prevent AFP from achieving its maximum potential. Fibre bridging at geometric features, overlapping or excessive gaps between tows, fibre misalignment, and fibre waviness are the most common defects generated during AFP deposition [2]. In addition, wrinkle formation, temperature overshoots, under-cure and residual stress formation during the consolidation-cure process can significantly affect the quality of the manufactured part. Development of discrete composite process models has allowed predicting defect formation to some extent. However, a holistic approach integrating all individual process models in a single chain has not been developed yet. This study aims at the development and implementation of a manufacturing process model framework for the entire AFP manufacturing process chain. This will enable the investigation of the interdependencies between the different manufacturing stages, which were so far ignored, and therefore contribute towards right first-time defect-free manufacturing processes with considerable benefits in terms of time and cost. To this end, a process simulation model focusing on the cure and consolidation processes in the case of AFP was developed. The model is three dimensional and was developed using the commercial Finite Element Analysis (FEA) code Abaqus [3]. It comprises three sub-models; a cure simulation model focusing on the heat transfer effects, a consolidation model and a residual stress model, respectively. The heat transfer model comprises the material sub-models of cure kinetics, specific heat capacity and thermal conductivity [4]. The consolidation model is a hyper-viscoelastic model able to predict thickness variation and wrinkles formation [5]. The residual stress model computes the development of the lamina properties as a function of the degree of cure and temperature and is able to predict residual stress formation and shape distortion [6]. All three models were implemented using Abaqus user-defined subroutines [3]. An L-shape laminate was manufactured in order to validate the developed model and the experimental data were compared against simulation results. It was indicated that the approach adopted here can lead to a more accurate representation of the underlying phenomena since the modelling framework is able to take into account the inputs and outputs of all the models at the same time. References [1] Lukaszewicz, D.H.J.A. Optimisation of High-Speed Automated Layup of Thermoset Carbon-Fibre Preimpregnates. Ph.D. Thesis, University of Bristol, Bristol, UK, 2011. [2] Heinecke F, Willberg C. Manufacturing-Induced Imperfections in Composite Parts Manufactured via Automated Fiber Placement. Journal of Composites Science. 2019 Jun;3(2):56. [3] Abaqus 2017 Documentation. https://www.3ds.com/ [4] Belnoue JH, Nixon-Pearson OJ, Ivanov D, Hallett SR. A novel hyper-viscoelastic model for consolidation of toughened prepregs under processing conditions. Mechanics of Materials. 2016 Jun 1;97:118-34. [5] Belnoue JP, Mesogitis T, Nixon-Pearson OJ, Kratz J, Ivanov DS, Partridge IK, Potter KD, Hallett SR. Understanding and predicting defect formation in automated fibre placement pre-preg laminates. Composites Part A: Applied Science and Manufacturing. 2017 Nov 1;102:196-206. [6] Johnston A. An integrated model of the development of process-induced deformation in autoclave processing of composite structures. University of British Columbia; 1997.

Speaker Biography:

Not Provided

Presenter Name: Sousani, Marina

Presenter Company: EDEM Simulation

Presentation Title: Understanding powder behaviour in an additive manufacturing process by using DEM

Session Title: 5A Manufacturing Process

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:30 PM

Keywords: DEM, powder calibration, coarse-grained analysis

Abstract:

This project presents a Discrete Element Method (DEM) simulation of an Additive Manufacturing (AM) process and introduces a complete workflow of creating virtual materials that replicate the real powders and analysis of particle data through continuum fields. This work is a collaboration between the commercial code EDEM, created by DEM Solutions Ltd, and the Barnes Group Advisors, who are experts in the field of AM. The handling of bulk solids, in the form of powders, is a fundamental process in a wide range of manufacturing industries. Some of these industries include the automotive, aerospace, and healthcare sectors that employ AM. AM includes various manufacturing processes that enables users to produce complex parts in a short amount of time. Thus, considered an established method to developing an agile manufacturing environment, that can drastically reduce the lead time from conception to the production stage. Different types of powders are the main material used in these AM processes and they are fed into various AM production equipments through delivery systems. The latter uses a prescribed volume of powders and controls its flow into the printers spreading systems, hence dictates the success or failure of the end product and influences the machine set-up needed. Furthermore, it is critical to understand the effect of powder properties on the mechanics of the system and optimise the equipment. Due to the sensitivity of powder properties to environmental and machine conditions, it is not straight-forward to determine what the optimal configuration may be. Consequently, trial-and-error testing, plus a reliance on know-how from previous work is often the method. This results in extension of the overall part production cycle, as well as increased cost. This work presents a simulation of an experimental dosing system using DEM and employs the coarse-grained approach to extract continuum fields from discrete data. Specifically, DEM is used to create a set of virtual materials that mimic the behaviour of two different powders through suitable characterisation tests and simulates the entire dosing processes to insure systematic delivery. The powders are modelled using a meso-scopic modelling approach to insure practical computational time, while taking into consideration the particle size and shape. Bi-sphered particles with aspect ratio of 1.25 are used to capture the effects of particle non-sphericity on the bulk behaviour of the material. The Edinburgh Elasto-Plastic Adhesion (EEPA) contact model was used to model the virtual particle interaction in order to capture the complex elasto-plastic-adhesive behaviour of powders. Furthermore, continuum descriptions have been very successful in describing the macroscopic physical behaviour of discrete systems, hence this approach is used herein to investigate the behaviour of the discrete materials by using continuum fields, like density, momentum, velocity and temperature. Fine powders are particularly challenging with complex elasto-plastic-adhesive behaviour that produce unwanted agglomeration phenomena hindering their flow. At the same time performing experiments is challenging due to the opaque nature of the system making. The methodology presented herein provides deep understanding of the mechanics of such solids, making such simulations an indispensable tool for complex industrial applications.

Speaker Biography:

I am holding BSc and MEng degrees in Civil and Structural Engineering and a PhD in Discrete Element Modelling (DEM) from Leeds University. I am a senior Research and Development Engineer and have over 6 years' experience modelling granular material using DEM as well as various experimental methods. I joined DEM Solutions Ltd in 2016, which has since been acquired by Altair Engineering Limited, and my role involves the modelling of complex applications using EDEM. I am also managing a number of research projects that are in collaboration with leading Institutes, as well as internal projects, which allows the implementation of the latest scientific advances in the EDEM software.

Presenter Name: de Briey, Véronique

Presenter Company: Royal Military Academy

Presentation Title: Using fluid dynamics for simulating exterior ballistics phenomena

Session Title: 5B CFD2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 11:40 AM

Keywords: Weapon Systems, CFD, Trajectory, Aerodynamic coefficients

Abstract:

In external ballistics, trajectography is the combination of calculation methods and techniques for predicting the trajectory of projectiles launched from firearms. When the projectile is not guided, it is thus a question of being able to predict the point of impact as soon as it has left the weapon, or inversely, to know the position to be given to the weapon in order to hit a target in a very precise manner. Depending on the application (artillery, small arms fire, anti-tank fire, etc...), more or less complex computational models must be considered, but generally speaking, if we go beyond the scope of short-range firing, it is necessary to know the aerodynamic coefficients of the projectiles in order to be able to evaluate all the forces and moments that apply to them in flight and then calculate a trajectory numerically. Nowadays, it is possible to find these aerodynamic coefficients by shooting in all velocity regimes, but the cost of the facilities and the time needed to carry out the tests are still considerable, especially for large calibres. This is why it is interesting to be able to simulate the flows numerically in order to quickly and reliably express these coefficients. Many CFD-based techniques have already been developed, but a major effort remains on the validation side of these techniques. One of the applications generating a lot of interest for the moment is long-range shooting (sniping). Indeed, the trend for precision ammunition is to always hit a smaller target with a higher probability at an ever-increasing distance . The last two decades revealed many new calibres, new weapon features and a large number of trajectory softwareâ€™s to reach this goal. However, there is no unanimous criterion yet to define properly and scientifically why a projectile is better than another one. Until recently, the calculation of trajectories for projectiles launched from rifles did not pose any real problems because as long as the projectile remained in the supersonic domain, its behaviour remained predictable and was characterized by mainly semi-empirical models. The existing softwareâ€™s are often drag based (point-mass model), with a fitting established to match real firing, but they do not account specifically for the sharp changes in aerodynamic forces when the projectiles reach the transonic zone. Nonetheless, the transonic domain has to be crossed by precision ammunition when reaching high operational ranges with the classical propulsion and its inherent velocities. Between the different aerodynamic coefficients, we can distinguish the so-called static coefficients (generated fairly easily by CFD), and the dynamic coefficients, linked to the different damping phenomena generated over time, which are more difficult to determine because of their connection to very unstable forces. While the first category is indispensable in all applications, the second category is above all necessary in the design phase of weapon-ammunition system, in order to ensure optimum projectile stability. If the damping is too small or too high, there is a risk that the projectile will not finish its trajectory with the right impact angle on its target, missing the desired effect (shaped charge, armour-piercing projectile, non-lethal impact, etc...). However, when a system is well dimensioned, knowledge of the static coefficients alone is in most cases sufficient for a fairly accurate trajectory calculation. The search for an efficient methodology for determining a complete set of aerodynamic coefficients numerically is nonetheless a priority for our department, in order to have all the data required to calculate the trajectories of any new weapon-ammunition system and assess its performance.

Speaker Biography:

Mrs Véronique de Briey has a master in engineering and is a doctoral candidate where she specializes in weapon systems and ballistics, more specifically in exterior ballistics. After working as officer in a tank unit, she chose the academic way as an assistant in the department of weapons systems and ballistics of the Royal Military Academy in Brussels. Despite the taken direction, she keeps in touch with the operational world for small arms support.

Presenter Name: Parry, John

Presenter Company: Siemens Digital Industries Software

Presentation Title: Increasing Product Reliability with Reduced Order Models

Session Title: 5B CFD2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:55 PM

Keywords: Computational Fluid Dynamics

Abstract:

Designing reliable Electronics products require a thorough understanding of the systems performance subject to a wide range of environmental or end user requirements. Traditional design approaches with CFD (Computational Fluid Dynamics) are not well suited for understanding Temperature response of a system. Transient analysis with CFD is a slow process by todayâ€™s design requirements. Fast Transient response is a method that has been used to accelerate the design process but hasnâ€™t been widely adopted by the thermal design community in part due to their Boundary Condition dependence. DCTMâ€™s (dynamic compact thermal model) represent another approach to reducing simulation time but there hasnâ€™t been a standardized or generalized approach to creating these models. DCTMâ€™s generally are not available. Reduced Order Modelling is an alternative approach to extracting a DCTM from a thermal simulation model. A BCI-ROM (Boundary Condition Independent Reduced Order Model) provides analysis speed, Boundary Condition Independence, and solution environment flexibility to facilitate the understanding of product reliability as related to temperature. This presentation discusses the current approaches available for analyzing the temperature response of an electronic system and introduces a new method for BCI-RIM development. Examples shown will include a handheld device and IGBT subject to the UDDS: FTP-72 Drive Cycle for an Electric Vehicle.

Speaker Biography:

Started in CFD in the mid 1980s as a Project Engineer at CHAM, using PHOENICS, the first commercial CFD code. Moved into customer support at CHAM, later managing that function for CHAM UK. Invited to join Flomerics as a start-up to head up Flomerics Customer Services function. Managed several European-funded research projects, leading to thermal modeling methodologies for electronics components and assemblies. Researched into other topics, including thermomechanical stress and organic heatsink shapes, with 4 pending patents. Now primarily involved in business development following the acquisition of Mentor Graphics by Siemens Digital Industries Software. Serves on the JEDEC JC15 Thermal Standards Committee, NAFEMS CFD Working Group, the Harvey Rosten Award for Excellence Selection Committee and on various thermal conference steering committees.

Presenter Name: Percival, David

Presenter Company: EnginSoft UK Ltd

Presentation Title: Employing advanced CFD to Predict Oil Distribution, Churning Losses and Gearbox cooling

Session Title: 5B CFD2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:05 PM

Keywords:

Abstract:

New Integrated Lightweight Electric Vehicles (ILEV) require a precision transmission that is both silent and durable in even the most demanding electric vehicle applications. To achieve such a high specification advanced simulation and analysis is required. The design process for P1227F, Xtracâ€™s new ILEV transmission, faced a fundamental design problem â€“ â€˜how can the design of the casing and other components be modified to ensure suitable distribution of lubricant throughout the gearbox?â€™ Traditionally, prototypes are created and tested to verify the overall gearbox oil system. The typical approach would be to replace the physical test with a computer simulation. However classic CFD methods, have had prohibitively high computational costs when solving free surface problems such as splashing lubricant within a transmission â€“ a task for which traditional method is not well suited. These classical methods require long setup and solve times, something which is unreasonable in the context of both automotive and motorsport design processes. This paper highlights how Xtrac collaborated with EnginSoft in order to use the MPS (Moving Particle Simulation) method to predict the lubrication distribution and churning losses of the P1227F gearbox. Simulation results were compared to video footage and data from physical testing conducted at Xtracâ€™s in-house research and development laboratory. The MPS method allows users to go from CAD to lubrication, churning loses and cooling results in a matter of days meaning simulation can be implemented during the design phase saving both time and money during prototyping.

Speaker Biography:

Not Provided

Presenter Name: Schüssler, Florian

Presenter Company: ACAM Engineering GmbH

Presentation Title: Numerical and experimental evaluation of tile stoves mode of operation

Session Title: 5B CFD2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 12:30 PM

Keywords: CFD, experimental evaluation, experimental verification

Abstract:

The efficiency and functionality of contemporary tile stoves are numerically evaluated using a commercial finite volume flow solver including heat conduction in solids and compared to experimental results. Careful selection of material and numerical parameters has been necessary to simulate the complete heating cycle over several hours, which so characteristic for this type of stove. The impact of the stoves heating cycle on the room temperature is investigated in a real scenario, where the stove is positioned in a generic house or flat as an unsteady boundary condition based on detailed preceding simulations of the stove itself. Comfort parameters are evaluated at different locations in the vicinity of the stove. I. Introduction Tile stoves have been used for centuries for heating of homes and houses. Typical for this type of stove is, apart from its construction, its particular usage due to its capabilities to store heat over a long time. The stove is mainly built from chamotte, a material with a high heat capacity but rather low heat conduction. Together with its peculiar interior construction, this type of stove is only initially heated up by burning fire wood and then emits heat for several hours. In the course of strengthening the usage of renewable energies, these stoves have regained popularity as well as due to their unchallenged look and feel. II. Results Figure (1) depicts the cad-model of one of the tile stove designs under investigation. The picture on the left shows the solid, in the middle picture, the fluid volume is extracted. For an experimental validation, the stove has been anufactured and equipped with sensors for data collection. Out of several locations for measuring the temperature during a complete heating cyle, fig. (2) shows a comparison of the temperature at two selected locations from the simulation and the experiment. Using infrared cameras, results from the simulation, depicted as contour plots of the temperature on selected surfaces can be compared to the experiment and are shown in fig. (3). III. Conclusion This contribution sums up the efforts and results from an investigation of tile stoves mode of operation. The results from the simulation using a finite volume flow solver show good agreement to experimental results. Several tile stove designs and its location in a room were investigated with its impact on room climate and human comfort factors. This project was funded by the Austrian Research Promotion Agency (FFG).

Speaker Biography:

Not Provided

Presenter Name: Bucklow, Henry

Presenter Company: ITI, a Wipro Company

Presentation Title: Rule-based Automatic Mesh Sizing for FEA and CFD

Session Title: 6A Innovative Applications

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 2:45 PM

Keywords: Meshing, Element Sizing, CFD, FEA

Abstract:

Demand continues to grow for robust and efficient automated numerical simulation pipelines. However, mesh generation remains a bottleneck, often requiring excessive human intervention. Progress continues to be made on robust, reliable unstructured mesh generators, but mesh sizing should not be overlooked as a critical component of the automatic meshing workflow. Appropriate mesh sizing becomes particularly important as the limits of simulation fidelity and complexity are reached. Excessive mesh density may produce accurate results but at the expense of an impractical number of degrees of freedom, whereas coarse meshes may fail to capture necessary details and render the simulation irrelevant. We have developed an extensive rule-based framework for automatic mesh sizing, where a series of rules can be combined into a single sizing field, which then drives intelligent element sizing during both mesh generation and smoothing operations. On edges, the mesh sizing field is held as a graph of mesh density along the edge. For faces and volumes, the mesh density is held as a metric tensor over a triangular/tetrahedral scaffold. This allows anisotropic mesh densities to be easily represented and provides a straightforward interface to many metric-based mesh generators. Using these density-based methods provides a natural way to combine multiple sources of sizing data. Typically, the first layer of sizing rules are geometric ones: SAG (elements must lie within a given distance of the geometry), TURN (maximum angle between neighbouring elements), and maximum and minimum element sizes. For the common case of isotropic meshing, edges are also sized using SCURV and STURN rules, which set sizing along an edge to meet sag and turn criteria in the transverse direction. More sophisticated geometry-based sizing rules, such as proximity, can also be applied. A 2D medial axis analysis of model faces allows a density to be calculated along edges which will ensure a specific number of isotropic elements internally across a face. User-driven or templated mesh sizing can be overlaid onto the sizing field. Mesh control sources are commonly used in aerospace CFD, and there are in-house tools available for generating templated sources for common configurations, providing sizing required to capture specific flow physics phenomena such as wakes. Source fields can be integrated with our sizing field to combine automated, templated and manual element sizing. Further transformations can also be applied to the sizing field. A RATMAX rule ensures that adjacent elements satisfy a maximum size growth ratio. The ANIMAX rule enforces a maximum anisotropy within a face interior. The MATCH rule ensures that sizes are matched between neighbouring edges, faces, and volumes, allowing sizing for unstructured faces and volumes to match sizing imposed by neighbouring structured meshes. Our sizing fields are constructed bottom-up: first a sizing field is built along edges, then we construct the field over faces, and finally we build a field in the volumes. The â€œback-propagationâ€� of sizing from faces onto edges can also be employed, which allows dense sizing along one edge to propagate through the interior of a face, and affect the density on a neighbouring edge. This ensures successful generation of good quality meshes even when automatic sizing indicates rapid changes in mesh density. We have implemented these mesh sizing techniques inside ITIâ€™s CADfix solution. The sizing rule framework is respected by the edge, face, and volume mesh generators, including isotropic and anisotropic triangular mesh generators, an anisotropic quad-dominant mesh generator, and isotropic and anisotropic tetrahedral mesh generators. We will demonstrate how these methods have been successfully applied to the CFD meshing of industrial airframe configurations, and FEA meshing of industrial turbofan components.

Speaker Biography:

Henry graduated from University of Cambridge in 2004 with a degree in Mathematics. He joined ITI in 2005, and has worked on feature removal, medial object, and shrink wrapping. Since 2016, Henry has been a product manager, responsible for developing next-generation meshing technologies.

Presenter Name: Guicheteau, Simon

Presenter Company: Altair Engineering Ltd

Presentation Title: E-Motor Development At Porsche: Using An Optimization-Driven Multi-Physics Design Process

Session Title: 6A Innovative Applications

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 3:10 PM

Keywords: electric vehicles, motors, optimization, multi-physics

Abstract:

More integrated and holistic development strategies will be necessary in the future to better meet the requirements of e-powertrain without significant sacrifices on target fulfillment. Optimization methodologies and processes offer opportunities to support such integrated development strategies. This presentation offers insight into how the advanced drivetrain development of the Porsche AG together with Altair have approached the challenge of improving the total design balance in E-motor development. It will be shown how different physics simulation and optimization tools are combined and integrated to create a process for multi-physics E-motor optimization. Some details on coupling strategies will be discussed and It will be shown that such a process has the potential to improve the total design balance compared to classical motor design methodologies. 1: Introduction Today, an e-motor cannot just be developed looking at the motor as an isolated unit; it must be assured that tight requirements concerning the integration into both the complete electric or hybrid drivetrain system and tight requirements concerning perceived quality are fulfilled. Thus, it is a necessity to develop the e-motor not in isolation but as a system to fit work optimally with other components and systems. Noise and power consumption are two of such integration challenges. 2: Multiphysics Optimization / Multi-Disciplinary Optimization Multi-disciplinary and multiphysics optimization methodologies make it possible to design an e-motor for multiple, completely different design requirements simultaneously, thus avoiding a serial development strategy, where a larger number of design iterations are necessary to fulfill all requirements and unfavourable design compromises need to be accepted. Design input and restrictions from design, packaging, production, etc. need to be considered when setting up the design optimization problem. Otherwise, the results will not be feasible or relevant. Finally, all input and restrictions need to be brought into one single optimization loop. 3: The Porsche / Altair Optimization Environment A baseline design is used as a starting point for the optimization. Design space is then created by defining variables (design variables, DVs) that influence the design. In this study shape variables, which influence the size and position of the magnets are used to create the design space. Depending on the choice of responses, several solvers must be used to perform one or more simulations to yield the necessary responses. If metamodel-based optimization is chosen, response surfaces of all responses are created based on the samples from the DoE (Design of Experiments). Optimization and design exploration can then be carried out using these response surfaces. A strength of DoE based optimization is clearly the ability to use the data to answer a large number of different questions and to play through numerous design scenarios. 4: The Design Problem Porsche is aiming at developing high performance e-motors with high requirements on key performance data such as power, torque and speed. Porsche and Altair agreed on applying a three-step optimization-driven design process aligned with the discussion in previous sections to develop a concept matching the above requirements. The three-step process will be outlined in the presentation but briefly comprises a baseline concept phase, a multiphysics development phase, and a final systems approach phase.

Speaker Biography:

Simon graduated from Grenoble Institute of Technology, School of Energy, Water and the Environment (Grenoble INP ENSE3) in 2013. He then joined CEDRAT as an application engineer looking after support, training, pre-sales and consulting around Flux software for electromagnetic finite element simulation. When CEDRAT were acquired by Altair in 2016, Simon became part of Altair UK, working as a Senior Application Engineer. Today, Simon specialises on electromagnetic and multiphysics applications around e-motors with key automotive OEMs and suppliers.

Presenter Name: Hafid, Sabrina

Presenter Company: ANSYS Europe Ltd.

Presentation Title: The story behind building the world's fastest fully electric aircraft

Session Title: 6A Innovative Applications

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 3:35 PM

Keywords: Electrification, battery cooling system, CFD, optimisation

Abstract:

Electrification is a major initiative across the aviation sector. Rolls-Royce is leading a small team of companies, including Electroflight (Gloucester), aspiring to break the record for the worldâ€™s fastest (300+ mph) full electric aircraft: project ACCEL (Accelerating the Electrification of Flight). To succeed, the ACCEL project must deliver ground-breaking new technology across electrical systems, energy storage, systems integration and controls. The battery assembly for ACCEL is the largest, most energy dense assembly ever used to an aviation application. A crucial aspect of the project success is managing battery thermal performance, throughout the aircraft operation. The batteries are assembled from individual, high performance cells, into multiple sub-assemblies and strings, each with active cooling systems. The cooling system comprises a series of heat-exchanger plates, feed by cooling water, through a series of inlet and outlet manifolds. The design of the inlet and outlet manifolds, in both forward and reverse flow, with a limited space envelope, an even flow split and with minimum pressure loss, is essential for the cooling system performance. In addition, the project, as a whole, is running to very tight timescales, so a fast turnaround at all stages is essential. Electroflight partnered with ANSYS to assist in the optimisation of the cooling system, specifically the cooling manifolds design. Within the overall project constraints, this required a new engineering design approach. A two-stage interactive and smart optimisation workflow was used for this study: - Firstly, an interactive GPU accelerated physics solver was used to explore the fluid volume shape, to optimise the manifold design and flow splits. This technique allowed manipulation of geometry, fluid types and physical inputs, with instantaneous feedback on changes in system performance. - A second stage using traditional CFD, with conventional meshing and discretisation, was used to validate the predicted manifolds performance and an Adjoint optimisation was performed, to tune the design and minimize the pressure drops. The adjoint solver calculates the best-performing shape with respect to a target variable(s) and automatically morphs the fluid volume shape. The results of the adjoint optimization can then be exported and reverse engineered, for manufacture. This workflow established optimal manifold concepts, that would achieve an even flow split, with the Adjoint optimisation further reducing the pressure drop by up to 46%. Subsequent adjustments to the manifold arrangement, required due to changes in the feed pipes and adjustments to the space envelope, were easily addressed by revisiting the workflow process. This project has demonstrated that a combined approach of fast-interactive physics simulation and Adjoint optimisation, can rapidly derive an optimal solution, replacing the need for otherwise lengthy parametric study.

Speaker Biography:

Sabrina Hafid is working as an application engineer at ANSYS UK and has over 7 years of experience in the simulation field. She is specialized in 3D and 1D fluid system analysis. She holds a master's degree in Mechanical engineering with a focus on aerodynamics and thermal.

Presenter Name: Aboukhedr, Mahmoud

Presenter Company: BETA CAE Systems UK Ltd.

Presentation Title: Evaluation of Volume Cavity Replacement Technique on Industrial High-Fidelity CFD Models

Session Title: 6B CFD 3

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 2:45 PM

Keywords: CFD, model build, replace volume, variant,

Abstract:

A relatively recent report published by NASA (CFD Vision 2030 Study: A Path to Revolutionary Computational Aerosciences, NASA/CR–2014-218178, 2014) identifies “Mesh generation and adaptivity” as one of the most significant deficiencies in the CFD workflow. In brief, the current link between simulation results and CAD models is rendered inadequate and poor mesh generation performance and robustness are highlighted as the main impediments causing CFD users to spend more time on mesh construction and maintenance, rather than focusing on the final solution. Moreover, increased human intervention required during the mesh generation phase is the main contributor towards increased cost of any CFD simulation that involves even lightly complex models. The report is dated six years ago and despite the advances in geometry clean-up, watertight-ing, common model build-up and meshing automation, the outcome is relatively similar due to the ever-increasing complexity in simulated models. Therefore, the challenges imposed on pre-processing software are significant, as it must deliver huge mesh sizes within the shortest time on a limited amount of hardware resources, while maintaining high-quality characteristics and promoting automation. Over the years, CFD users did apply several workarounds to achieve reduction in preparation and meshing times of model variants; however, they result in limited model flexibility and rely heavily on the human factor. In this study, we investigate the impact of a new meshing technique that promises volume cavity replacement on external aerodynamics results of an open-wheel racing Champ Car, simulating different set-up variants. Seamless integration with data management systems, “intelligent” hybrid volume (re-)meshing (featuring prism layers and mixed Hex-Tet meshes) and automated domain splitting are some of the key features utilised to dramatically reduce preparation and meshing times of several aerodynamic package variants of the Champ Car. Investigations include method evaluation based on quantitative results on meshing times and impact of mesh quality and cavity interconnectivity on the calculated flow field variables. Results presented in this study demonstrate an immense time reduction in preparation and meshing times of model variants, an unmatched mesh reproducibility and robustness between baseline and variant models, while maintaining high-quality mesh metrics according to solver requirements. In addition to method robustness, it was also concluded that the link between geometry and meshed model was improved due to direct association of original parts in the absence of dividing geometry boxes. The proposed volume cavity replacement method partially resolves known issues of CFD models of sizes from tens to hundreds million elements, while it also manages to minimise human interaction without compromising quality. Finally, such developments are potentially taking the CFD community closer to “results re-use” for minor local design changes.

Speaker Biography:

Mahmoud Aboukhedr holds a Ph.D. and MSc in Mechanical and Aeronautical Engineering from City, University of London, UK. He is currently a CFD (Computational Fluid Dynamics) Application Specialised at BETA Systems CAE UK. Mahmoud’s interest lies within the realm of automotive aerodynamics and multiphase fluid dynamics with an emphasis on computational modelling. Also, he have been involved in developing and applying computational solutions to a wide range of problems including, but not limited to aerodynamics, multiphase flow modelling and thermodynamics using different computational fluid dynamics software’s and tools such as OpenFOAM and Fluent. Dr. Aboukhedr presents a proven track record of +8 years of experience in CFD modelling and process developments for different disciplines.

Presenter Name: Basso, Alessio

Presenter Company: TWI North East

Presentation Title: Process Optimisation in Robotic Arc Welding by Computational Fluid Dynamics Methods

Session Title: 6B CFD 3

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 3:35 PM

Keywords: CFD, robotic arc welding, process optimisation

Abstract:

Industrial multi-axis robots are widely used in arc welding processes to increase productivity and to improve the quality of welded components. Robotic arc welding is becoming more and more popular, seeing increased use in automotive and electronics sectors, as well as aerospace, rail, power generation and oil & gas. Due to the complexity of the physical phenomena involved in arc welding processes, the majority of the research and development is focused on optimising processing conditions for a new welded product. This is often an exercise based on trial-and-error experimentation which can lead to high costs and significant lead times. Additional time is also required to translate the optimised conditions into the robotic equipment setup. For the above reasons, numerical modelling is a powerful tool that can be used to accelerate the process of identifying the appropriate welding parameters by developing, implementing and validating an associated manufacturing process simulation. Conventionally, solid mechanics approaches are used to model welding phenomena: a thermal model simulates the temperature transients due to a moving heat source, and a mechanical model is used to predict distortion and residual stress. However, computational fluid dynamics (CFD) enables the prediction of how material is deposited and flows during welding. This enables for an improved understanding of the relationship between processing parameters such as wire feeding rate, travel speed, arc voltage and current and other physical properties such as root penetration, weld cap height and weld cap width. The CFD analysis undertaken in this work makes use of the volume of fluid (VOF) and melting sub-models coupled with the modelling of the thermal energy to track the solid-liquid interphases of the weld material, as well as the weld thermal profiles. As a result, the final weld shape and size of the measured fusion zone can be accurately predicted. This model was validated against weld macrographs and thermocouple data. The validated simulation methodology was then used within a design-of-experiments framework to generate a response surface function linking the processing condition parameters to the weld shape. This is now being used directly by the robot controller to effectively produce the weld.

Speaker Biography:

BEng in Aerospace Engineering from University of Palermo, Italy (2011) MEng in Aerospace Engineering from University of Palermo, Italy (2011). MRes in Fluid Mechanics from Von Karman Institute, Belgium (2013). Mphil in Mechanical Engineering from The University of Nottingham (2016). Research Associate at Teesside University (2017-2018). He is currently a Project Leader focussing on application of Computational Fluid Dynamics, Multi-physics and Fluid-Structure-Interaction modelling techniques for consultancy, research and development. Focus on thermal fatigue in natural gas dehydration vessels. Design optimisation of pressure sensors, additively-manufactured heat exchangers with complex geometries. Manufacturing process simulations (specifically prediction of melt pool dynamics and material deposition techniques in welding and additive manufacturing).

Presenter Name: Khawaja, Hassan

Presenter Company: UiT The Arktic University of Norway

Presentation Title: Windtech Technology - Measuring Cold Exposure via Conjugate Heat Transfer

Session Title: 6B CFD 3

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 2:20 PM

Keywords: Cold Exposure, Extreme Weather, Disruptive Technology

Abstract:

Windtech technology is based on a novel patented technique of measuring cold exposure (UK Patent Office Application Number: 1914757.8, titled: Measuring cold exposure, dated: 11th October 2019). In this technology, the cold is measured via the response of an electrical heater exposed to environmental elements such as ambient temperature, wind, humidity, and irradiance. In this technology, the heater is set at a fixed wattage (however, may be set on variable wattage considering the application) when exposed to the environmental elements. When in operation, the heater stabilizes at a temperature referred at as a "heated-temperature" in a short period of time. This value is calibrated against the heat loss, which reflects a cumulative effect of all environmental elements and gives a more realistic value, or in other words, the 'the true feeling of cold'. The technology is equipped with a number of sensors measuring ambient temperature, humidity, irradiance, and wind speed. The technology does not have any moving parts, provides a more reliable and stable output of data, and can be integrated with other systems. The technology can be used in a solo device (wearable) or a mesh of multiple devices (weather stations) placed over an area/region. The technology uses digital means of communications such as USB connectivity, Bluetooth, WiFi, 3G/4G networks, etc. Windtech technology is validated by developing a 3D conjugate heat transfer (coupled computational fluid dynamics and heat transfer) model in a commercial software ANSYS® CFX. The developed model was tested for mesh sensitivity. The conjugate heat transfer model was run for parametric analysis under various environmental conditions. The results were compared quantitatively and validated against the experimental results of the prototype. The results obtained through the simulations played an important role in optimizing the prototype design. Windtech technology is striving for following UN SDGs: Goal 3: Good Health and Well-Being: Windtech technology, primarily focusing on the good health and well-being of the people living and working in cold climates. It helps in accurately predicting the risks due to cold and suggests safety actions and measures actions according to ISO standards e.g., ISO 11079. Goal 4: Quality Education: Windtech technology is born in academia (UiT-The Arctic University of Norway). Norninova AS technology transfer and Norinnova Startup IX has supported it. So far, four Master students have done their specialization and these projects on the topic. There is ongoing research on the development of technology. Goal 8: Decent Work and Economic Growth: It is vital to know the 'working conditions' in the Arctic and cold regions in general, for decent working conditions and sustainable economic growth. Windtech technology provides a tool to assess the risks accurately due to the cold weather hence offer a clear and concise mechanism to make appropriate decisions, saving the workforce from any harm. Goal 9: Industry, Innovation, and Infrastructure: It is well-known that oil and gas/fisheries/mining and others are growing in Arctic and cold regions. The workforce must be provided with safe working conditions. Windtech technology is an innovative tool to help with that. Windtech AS has applied for a patent (UK Patent Office Application Number: 1914757.8, titled: Measuring cold exposure, dated: 11th October 2019). Goal 11: Sustainable Cities and Communities: Windtech AS provides a tool to assess the working conditions of personnel exposed to cold weather. The information helps the city authorities, as well as companies management, to take appropriate actions. These actions help with sustainability as well as the well-fare of the community. Goal 15: Life on Land: Windtech device is an essential tool for the 20% part of the landmass, which is too cold, hence provides a risk to the personnel as well as the general workforce. Goal 17: Partnerships for the Goals: Windtech technology is a tool and, therefore, may be integrated with other technologies in partnerships for more SDGs.

Speaker Biography:

Windtech AS / University of Tromsø – Norway / Al Ghurair University – UAE Completed PhD in Engineering from University of Cambridge, UK in 2013 Specialization topics: Fluid Mechanics, Heat Transfer, Multiphase Flows, Fluid-Solid Interactions, Multiphysics Modelling Authored 3 books, published 40+ peer-reviewed journal articles, 80+ conference presentations, collaborated in 30+ research grants applications, managed 10+

research and development projects, entrepreneur, held executive positions in the scientific/scholarly societies. Chairman of the Board at Windtech AS, Adjunct Associate Professor at University of Tromsø – Norway Associate Professor at Al Ghurair University – UAE Vice President at The International Society of Multiphysics

Presenter Name: Mallyala, Rachana Rao

Presenter Company: Dassault Systèmes

Presentation Title: Design and Optimization of Cooling System Component for Enhanced Airflow

Session Title: 6B CFD 3

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 3:10 PM

Keywords: Fluid mechanics, Cooling, DOE, Optimisation, Lattice Boltzman

Abstract:

Engine cooling is a challenge across industries, such as Automotive and Industrial Equipment. Many equipment manufacturers focus mainly on meeting engine certification at a specific ambient temperature without realizing there is potential for additional airflow. A typical combustion engine generates a significant amount of heat, of which around 35% to 40% must be dissipated by the engine cooling system. The fan and fan shroud are critical components of the engine cooling system as they provide the necessary airflow through the engine radiator required to take the heat away from the coolant. In addition, the design of fan and fan shroud must meet packaging space requirements, which can increase the complexity of the cooling system. By maximizing the performance of fan and fan shroud, the cooling system can be improved through an increase in airflow, or a better distribution of the airflow across the radiator. Both improvements can lead to a reduction in fan speed, a reduction in fan power, longer operational life and possibly lower operating cost. Through exploration of a design space, leveraging optimization analysis, the impact of fan and fan shroud design parameters on the total airflow can be investigated to achieve optimal performance without constraining the design change to simple iterations from a baseline. This is even more critical when the equipment manufacturer is utilizing molded fan shrouds, as the optimal design must be achieved before implementing the costly initial mold tooling. With a better understanding of the key shape parameters early in the development schedule, the need for multiple tests and iterations late in the development schedule can be removed, reducing the number of molds to ideally just one. In this study, a series of design of experiments and optimization of a fan and fan shroud were performed on an excavator to achieve maximum cooling airflow. The fixed design space for this engine cooling system covered design parameters such as tip clearance, fan to radiator distance, fan shroud depth and curvature and fan shroud ring depth. The performance of the system is assessed using a Lattice Boltzmann-based Method known for its best-in-class accuracy at predicting cooling performance. The final configuration of optimal design shows a 15% improvement to the initial one and illustrates how most machinery with similar configurations of fan and fan shroud can leverage such optimization approaches to help reduce total development time and cost.

Speaker Biography:

Not Provided

Presenter Name: Dean, James

Presenter Company: Double Precision Consultancy

Presentation Title: Democratization of the Dough Baking Process

Session Title: 6C Simulation Governance

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 2:45 PM

Keywords: Democritization, Food, COMSOL, App

Abstract:

An â€œAppâ€� of a PepsiCo baking process has been created using COMSOLâ€™s Server and App capability. A user-friendly interface has been created that runs a sophisticated COMSOL model in the background providing all the power of modelling & simulation to users at PepsiCo without the need to understand simulation and its underlying mathematical model. The creation of this App enables virtual experimentation that saves time by being faster than physical tests but also saves the costs of raw ingredients and overheads for running the physical trials. The underlying COMSOL model simulates a multistage convection oven and a finished drying process based on one of PepsiCoâ€™s pilot-scale ovens. The App has options for both 2D and 3D simulations giving the user the flexibility to choose the trade-off between accuracy and speed. The COMSOL model simulates a number of physics: Solid Mechanics, Heat Transfer and Mass Transfer. By simulating these physical phenomena, the model captures shape change, temperature profile through time and moisture removal through time. The user also can modify both the oven parameters including zone temperature, humidity and fan speed and the product recipe including the percentage starting moisture of the dough. The model has been assessed in terms of its accuracy, usability and computational stability to ensure it is fit for purpose for its users at PepsiCo. This includes assessing the need for non-linear representation of certain parameters and decoupling physics where possible to speed up run time.

Speaker Biography:

Not Provided

Presenter Name: Norris, Mark

Presenter Company: the SDMConsultancy

Presentation Title: A value-focussed approach to the deployment of Simulation Data Management in Aerospace

Session Title: 6C Simulation Governance

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 2:20 PM

Keywords: Simulation Data Management, System of Record, SDM, Simulation Process and Data Management, SPDM, Simulation Management, Simulation Lifecycle Management, SLM

Abstract:

Simulation Data Management (SDM) is a class of application pioneered by Automotive and Aerospace OEMs and Tier 1 suppliers that rely upon simulation within their product development processes to achieve industry-leading performance. It allows them to build and maintain the Digital Thread of both the data used and the decisions taken to predict the performance and lifetime of engineered products. While SDM solutions have proved highly effective at a small number of leading companies, the overall adoption of information systems to manage simulation data by simulation engineers is still extremely low at 1%-2%. The SimBest study[1] conducted interviews of 170 simulation engineers in UK companies and found no one using an SDM or other solution to manage their simulation data-sets. The study concluded that â€�there is little formal use of SPDM even though it is seen as important and necessaryâ€� and that â€œSPDM and SPLM systems are perceived as very costlyâ€�. Best practice to deploy SDM has been to implement one end-to-end process at a time, providing end-to-end process traceability and enabling a simulation team to migrate from notebooks and shared drive file systems to a robust information system. Typically SDM has been deployed for critical processes such as automotive crash simulation or for new simulation processes such as Virtual Testing of critical systems. This ensures that critical simulation processes are secured and has been found to yield productivity and engineering throughput improvements. But because large simulation organisations typically have 100 simulation applications, complete SDM deployment takes several years. There are two disadvantages with this sequential approach: â€¢ Other simulation engineers have to wait potentially years until the project phase in which their process chain will be implemented in SDM to gain any benefit from SDM â€¢ Digital traceability of simulation results is incomplete until all domains have been implemented in SDM which is unsatisfactory in safety critical industries. A survey of simulation engineers and managers identified that their first priority for improving simulation management is a System of Record for all the formal information created for a simulation together with all the relevant files in a single location. In the aerospace industry, similar simulations are run several times at the different stages of a program: concept evaluation, preliminary design, detail design, design validation/virtual test, design validation based on loads from flight testing, aircraft performance upgrades and in-service. There is therefore a significant benefit both to simulation engineers and the organisation if all the formal information related to a simulation is catalogued in a system of record and the key files are immediately accessible for re-use. The MoSSEC standard is under development which defines a Simulation Study, an information object which groups together the Simulation context, inputs, methods and tools used, final versions of key files, results and reports. The planned deployment approach for simulation management is therefore to first implement a System of Record based on the MoSSEC Study concept which will provide a single, catalogued, point of archival of formal simulation data followed by a progressive implementation of work-in-progress SDM for individual process chains. This will provide immediate benefits to all the simulation engineers as well as traceability to the enterprise. It will facilitate multi-disciplinary simulation and lay the foundation for full deployment of SDM and the evolution to SPDM with further process automation and productivity.

Speaker Biography:

Mark Norris began his engineering career developing a method for the simulation of crack propagation in aircraft structures. He has 35 years of experience of consulting and implementation of information systems for industrial companies. These include Simulation, Computer Aided Design, EDM, PDM, PLM and Simulation Data Management. He has worked for industrial companies, a research institute, software vendors and a leading IT/Engineering consultancy. Half his working life has been spent in France. He has delivered projects for companies in the sectors of Aerospace, Defence, Gas Turbines, Shipbuilding, Automobile, Industrial machinery and Consumer Goods. Mark believes in Best Practices, Methodologies and Training as key factors in the successful deployment of information systems. He has taught and practiced Solution Delivery and consulting methodologies. He has developed training materials for Aerospace PLM user training for a Defence company and trained 900 engineers. He developed and delivers the NAFEMS Simulation Data Management training course. He is the author of the NAFEMS Simulation Data Management Business Value White Paper and 10’s of papers, articles and presentations to international conferences on SDM and SDM deployment. He developed the NAFEMS SDM bibliography so that members can find each of the 200+ papers on SDM.

Presenter Name: Norris, Mark

Presenter Company: the SDMConsultancy

Presentation Title: How to succeed at SPDM

Session Title: 6C Simulation Governance

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 3:10 PM

Keywords: SPDM, SDM,

Abstract:

Simulation Data Management (SDM) is a software solution which enables Professional Simulation Engineers to find information, run simulation applications and store results. An SDM solution records and displays the Digital Thread and records of engineering simulations. It replaces record keeping in notebooks and file storage on shared drives with structured digital records in a secure, searchable repository. SDM has been pioneered by high performance Automotive and Aerospace OEMs and Tier 1 suppliers over two decades. Organisations typically start the transition to the management of simulation data in an SDM repository when the complexity and size of their simulation data-sets make it no longer practical to manage them using manual record keeping. SDM is usually deployed by organisations which use numerical simulation as the basis for engineering decisions with significant economic or safety consequences. Capable SDM solutions have proved highly effective at these leading organisations to ensure that the right data has been used and to assure simulation quality. SDM provides increased confidence in simulation results by the capability to display the graph, or digital thread, which traces the simulation process from the initial simulation request as a sequence of process steps leading to the final results. SDM projects offer a good ROI to medium sized and large simulation organisations, but are inherently costly and time consuming due to the diversity of simulation applications and processes and a lack of experienced SDM implementation staff. SDM solutions support process improvement initiatives which typically take the As-Is processes recorded by the SDM solution as the starting point to formalised, standardise and optimise processes. SDM solutions have been enhanced to provide flexible simulation process automation and are often referred to as SPDM solutions. Successful adopters of SDM have reported substantial gains in engineering throughput through the elimination of laborious, non-value-added data management tasks, increased reuse of data and knowledge as well as the progressive automation of repetitive tasks. It is important to emphasise that the most successful SDM solutions support numerical experimentation by skilled analysts; they have not sought to prescribe inflexible processes. It is a common misconception that SDM solution seek to enforce prescriptive workflows, a typical PDM approach for CAD data, which has proved inapplicable to simulation management for experienced analysts. Successful SDM projects have been characterised by clear objectives, a focus on delivering value to the analyst and the organisation, and achieved through the implementation of a mature, capable SDM solution by a specialised and experienced services team. However, overall adoption of information systems to manage simulation data by engineering analysts is still pitifully low at 1%-2%, as evidenced in the SimBest report. Complementary approaches for managing limited subsets of simulation data have emerged. Analysis Planning and Reporting is an important technique applicable to organisations of all sizes and is valuable in its own right and to prepare for an SDM deployment. Simulation-enabled PDM is used for the management of meshing and of simple datasets created in CAD-embedded applications by design or manufacturing engineers. SDM is still an emerging domain with proposed solutions of widely varying capability and maturity. Solution selection needs to focus on capabilities, ergonomics, ease of adaption and on openness to manage the wide variety of simulation software found in most organisations. Selection should be based on practical testing of solutions' capabilities with your applications, data and processes and include a Proof of Concept. Un-successful projects to implement solutions to manage simulation data have been characterised by attempts to implement inappropriate or immature IT solutions by service teams without experience of simulation or of managing simulation data and a disregard for the specific needs of the simulation community. This presentation provides a summary of the key points to consider in order to succeed with a project to manage your simulation data and enable the transition to simulation driven development.

Speaker Biography:

Mark Norris began his engineering career developing a method for the simulation of crack propagation in aircraft structures. He has 35 years of experience of consulting and implementation of information systems for industrial companies. These include Simulation, Computer Aided Design, EDM, PDM, PLM and Simulation Data Management. He has worked for industrial companies, a research institute, software vendors and a leading IT/Engineering consultancy. Half his working life has been spent in France. He has delivered projects for companies in the sectors of Aerospace, Defence, Gas Turbines, Shipbuilding, Automobile, Industrial machinery and Consumer Goods. Mark believes in Best Practices, Methodologies and Training as key factors in the successful deployment of information systems. He has taught and practiced Solution Delivery and consulting methodologies. He has developed training materials for Aerospace PLM user training for a Defence company and trained 900 engineers. He developed and delivers the NAFEMS Simulation Data Management training course. He is the author of the NAFEMS Simulation Data Management Business Value White Paper and 10's of papers, articles and presentations to international conferences on SDM and SDM deployment. He developed the NAFEMS SDM bibliography so that members can find each of the 200+ papers on SDM.

Presenter Name: Khapane, Prashant

Presenter Company: Jaguar Land Rover

Presentation Title: Digital Twin : Myth or Reality?

Session Title: 7A Digital Twins

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:15 PM

Keywords:

Abstract:

Speaker Biography:

Not Provided

Presenter Name: Pimanov, Daniil

Presenter Company: IK CTO LLC

Presentation Title: Hardware and Software System for Managing the Life Cycle of Gas Turbines

Session Title: 7A Digital Twins

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 5:05 PM

Keywords: Digital twin, simulation, multiphysics

Abstract:

The paper presents the current progress of the Satratek, Novosibirsk, Russia on the creation of a digital twin of the Ansaldo Energia v64.3a gas turbine. Issues and results are presented and discussed. At present, gas turbine plants are widely used in the Russian Federation and the rest of the world to generate electricity and heat, as well as in gas transportation. Most of these plants have a long operating time and are not serviced by the manufacturer. Also, maintenance and repair procedures are in transition from planned to condition-based. This project will allow equipping gas turbines that are not serviced / warranted with a modular system to solve a wide range of industry tasks: early detection of emergencies, optimizing the mode of operation, predictive maintenance and repair, reducing risks of condition-based maintenance. To solve these tasks a hardware and software system is being developed. The hardware and software system consists of the following elements: modular system for collecting and storing information; an integrated model of a gas turbine that combines the models of critical elements; data analysis and predictive analytics module; software module for solving optimization problems; graphical user interface for data visualization and issuing recommendations. The data gathering module collects data from sensors of pressure, temperature, flow rate of fuel and air, vibration and noise installed on a gas turbine. It is responsible for conversion of signals from analog to digital, buffering, preprocessing and data transfer. Data is collected from the SCADA as well as additionally installed sensors. The data is stored for subsequent analysis. An integrated physical and mathematical model of the turbine is deployed. It contains a model of a combustion chamber, thermal barrier tiles, blades, etc. The model is calibrated and verified by the received telemetry data. The data analysis and predictive analytics module includes a neural network that allows detection of emergencies or suboptimal operation conditions â€“ system imbalance, rotor curvature, large radial loads and misalignment, stator and rotor contact, loss of stability caused by leakage, cracks in the shaft, wear of blades and tiles of a turbine, etc. The module also includes a recommendation system which allows predicting the wear of components depending on the operation mode, optimizing maintenance and repair procedures.

Speaker Biography:

Candidate of physical and mathematical Sciences (2019) Graduated from Novosibirsk state University (master's degree in 2014) Leading specialist of the modeling Department Static strength of structures, programming, digital twins

Presenter Name: Vikhorev, Konstantin

Presenter Company: The Virtual Engineering Test Centre (VEC)

Presentation Title: Digital Twins in the Nuclear Industry: Implementation and Key Lessons

Session Title: 7A Digital Twins

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:40 PM

Keywords: Digital Framework, Digital Twins.

Abstract:

ABSTRACT Industry is becoming more complex, geographically distributed and agile. These challenges mean that it is increasingly difficult to operate, communicate effectively and manage complexities without utilising digital frameworks to ensure the right information is presented to the right people at the right time to allow effective decision making. The concept of digital twins and integrated digital frameworks is well known and reported in literature. There is significant ongoing research into the technology development of digital twins and integrated digital frameworks, supported by the adoption of Internet of Things (IoT) enabled devices and Industry 4.0. However, the realisation of benefits from these technologies is still in its infancy and concern exists that adoption may be impractical and cost prohibitive. The UK Government has funded two phases of Digital Reactor Design (DRD) programme, an attempt to take a step towards the realisation of the Integrated Nuclear Digital Environment (INDE), a framework for integrating research, design, test, and operational data with a vision of having a digital twin of each new reactor designed and built in the UK. Through the development of this a proof of principle digital framework for the UK Civil Nuclear industry, a pragmatic and feasible approach has been demonstrated that has broader cross industrial applicability. As key technical contributors to this innovative programme, this paper discusses examples from the Digital Reactor Design programme and the development of digital frameworks and highlights the vision for such integrated digital systems and their use within highly regulated industry, such as the nuclear sector. The development path for digital twins is proposed together with a discussion of different levels of digital twin complexity and applications. It also describes practical examples of implementing digital frameworks as well as key lessons learned from involvement in nuclear research programmes and gives insight to wider adoption across multiple industries.

Speaker Biography:

Senior Project Engineer and Simulation Team Leader at the Virtual Engineering Centre (VEC), University of Liverpool. I am leading various commercial and academic projects funded by BEIS, EPSRC, DSTL. I am specialiasing in the field of real-time autonomous intelligent systems for industrial applications, developing digital frameworks and twins and data analytics. I obtained my PhD at the School of Computer Science, University of Nottingham in 2010.

Presenter Name: King, Stephen

Presenter Company: Dassault Systemes UK Ltd

Presentation Title: A conceptual study of an externally cooled, high voltage underground cable crossing

Session Title: 7B CFD 4

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:40 PM

Keywords: CFD,3DEXPERIENCE

Abstract:

The transmission of electrical power at high voltage over any significant distance can be achieved either by using pylons supporting overhead lines or by using underground power cables. Although generally cheaper to install, the use of overhead lines has a number of issues, not least of which is the environmental impact of such installations and the potential health and safety concerns close to residential developments. In consequence, much of the power distributed in the UK is distributed by cables that are buried underground in troughs, ducts or tunnels. Inevitably, with the continually developing UK power network infrastructure, new cable circuits may, in some cases, have to traverse existing underground circuits that have been operating successfully for many years. This can cause significant problems as underground power cables are carefully designed to be able to transmit the required amount of power without exceeding the limiting conductor temperature of 90 degrees centigrade. In isolation, the temperature of the conductor depends on the power losses generated by the cable and the thermal conditions of the local environment. For a direct buried circuit this is heavily influenced by the depth of burial below the ground surface. For the scenario where a new cable circuit needs to traverse an existing cable circuit, the new circuit can either pass above or below the existing circuit. Notwithstanding the restrictions on either of these options, the mutual heating effect between the circuits in the vicinity of the crossing will almost certainly mean maximum conductor temperatures are exceeded on both circuits, and hence the cables will need to be de-rated i.e. not carry the amount of load for which they were designed. From a distribution utility point of view this is a highly undesirable option. The only practical alternative in this situation is to somehow provide additional cooling to the cables in the region of the crossing, such that both circuits can operate at the desired rating. This paper describes a study of one such scenario where a new 400kV circuit is required to traverse two existing 132kV circuits. The aim of the study was to estimate the maximum conductor temperatures on both circuits for seasonal rated currents in the presence of an external cooling mechanism, consisting of air flowing in ducts that pass between the cable circuits. Experimentation is almost always not possible for installations of this type, so the only practical alternative is to use numerical simulation in the form of conjugate heat transfer analysis in a 3-D numerical model involving both heat conduction and fluid convection. As a conceptual study, the possibility of using induced natural convection as well as forced-flow convection was considered on a full 3-D model of the complete installation in the vicinity of the cable crossing. The heat transfer model was constructed using the CFD functionality available in Dassault Systemes 3DEXPERIENCE platform including CAD generation, meshing, analysis and results post-processing.

Speaker Biography:

After graduating from the University of Bradford with a degree in Mechanical Engineering, he worked as a design and development engineer at BICC Supertension Cables before joining SIA Computer Services in London. After several years supporting customers using NASTRAN, he then moved to Istel Automation in 1983 where he first became involved with Abaqus. After having established a project services business based on Abaqus from Istel's London office, he then moved back to BICC Supertension Cables to run the new Engineering Analysis department, where he was responsible for providing solutions for a variety of design, manufacturing and operational problems involving HV power cables, mostly using Abaqus but also CFD programs such as FIDAP and CFX. Following the acquisition of the Supertension Cables Division by Pirelli, the opportunity arose in 2001 to instigate and develop the Southern UK office of HKS UK Ltd, which itself was acquired by Dassault Systemes in 2005. Since that time he has been supporting customers and running services projects using Abaqus, and over the last several years has become involved with CFD on the 3DEXPERIENCE platform and with the lattice Boltzmann based software, XFlow, which was acquired by DS in 2016.

Presenter Name: Tristanto, Indi

Presenter Company: Rolls-Royce Group PLC

Presentation Title: A Reduced Order Modelling for Flight Mechanics Simulation of a Tilt Wing EVTOL Concept Hovering in a Cross-Wind Condition

Session Title: 7B CFD 4

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:15 PM

Keywords: Reduced Order Modelling, Electric Aircraft

Abstract:

Indi Tristanto, Mika Okuhara, Shahrokh Shahpar, David Fillingham Central Technology, Rolls-Royce The advent of distributed propulsion system for a greener aviation has led to novel aircraft concepts with an integrated airframe / propulsion system, such as the tilt wing Electric Vertical Take-Off/Landing (EVTOL) concept, in which a number propulsors are attached to the wing. While the cruise configuration is effectively identical to conventional aircraft, the vertical configuration with the wing tilted upward requires a different system. In hover and vertical flight, aircraft control can be achieved by varying the propulsor thrusts that produce most of the lift to augment the conventional control surfaces. A relatively simple blown wing model that rely on classical linear aerodynamic could be used for modelling the flight mechanics. The flow over the wing can remain attached, even if the wing is set at perpendicular angle relative to the fuselage axis, when the propulsor slipstream, which is aligned with the wing, is the most dominant flow, such as the case of hovering in a calm atmosphere. However, the accuracy of such model degrades significantly when the EVTOL is hovering in a strong cross flow condition since flow separation occurs over a portion of the wing due to incoming wind that arrives at high incidence relative to the wing exerting comparable influence to the propulsor slipstream. An improved flight mechanics model of hovering EVTOL in cross flow can be developed using RANS (Reynolds Averaged Navier-Stokes) CFD. However, CFD computation over the whole 3D aircraft model, even with simplified tilt wing geometry, is too expensive for a practical flight mechanics model. Hence a surrogate CFD model with significantly lower computational cost is desirable. In this work, a Reduced Order Model (ROM) that is based upon Singular Value Decomposition of a 3D RANS CFD field is being investigated with encouraging initial results.

Speaker Biography:

After graduating from University of Bristol with a Bachelor degree in Aerospace Engineering, Indi Tristanto went on to complete his PhD on development of Large Eddy Simulation techniques for compressible turbulence flows with jet noise applications at Loughborough University. Prior to joining Rolls-Royce as CFD methods developer in 2006, he had a brief stint as CFD and Aerodynamics lecturer at the School of Mechanical, Aeronautical and Civil Engineering at University of Manchester. His primary research interest is numerical modelling using in-house as well as commercial CFD codes of aerothermal and operability for gas turbine aircraft propulsion system as well as thermos-fluids and hydro-acoustics of marine and industrial power systems, such as Solid Oxide Fuel Cells and underwater turbines. From 2012 until 2016, he became an honorary research fellow on advanced gas turbine aerothermal at Loughborough University as an Industry Fellow of the Royal Society. Recently, his research interest also includes interactions between airframe and hybrid turbo-electric propulsion system.

Presenter Name: Hosseini, Fouzhan

Presenter Company: Numerical Algorithms Group Ltd

Presentation Title: Parallel Engineering Codes: Performance Optimisation with POP Methodology

Session Title: 7C Innovative Applications

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:40 PM

Keywords: Performance Optimisation, Parallel Performance Assessment, Code improvement, POP metrics

Abstract:

Parallel computing is an essential tool for engineering analysis and simulation codes, whether they run on desktops with a few computing cores, use accelerator hardware such as GPUs, or run on in-house clusters or HPC facilities. Improving the efficiency of engineering software running on these facilities either speeds up time to solution or allows for larger, more challenging problems to be solved. Parallel Performance optimization is, however, a complex task and it often becomes a daunting challenge. Here is where the Performance Optimisation and Productivity (POP) Centre of Excellence comes into play [1]. POP, funded by the EU under the Horizon 2020 Research and Innovation Programme, puts the world-class HPC expertise of eight commercial and academic partners together [2]. Our remit is to improve the performance of both academic and commercial parallel codes. Working with developers and users we promote a methodology for understanding a codeâ€™s performance which helps us go on to improve it. In this talk, we will present the importance of code analysis and the POP systematic approach to performance assessment and optimization. Measuring application performance often results in large amounts of data that is difficult to handle or interpret beyond some simple first observations. Our experience shows that there is often a lack of a quantitative understanding of the actual behaviour of parallel applications. POP methodology is based on a set of hierarchical metrics. These metrics provide a standard, objective way to characterise different aspects of the performance of parallel codes, each metric reflecting a common cause of inefficiency. This methodology provides the knowledge necessary to decide the best course of action to get performance via reproducible and comparable measurements of the performance. In the first phase of POP we investigated thirty-four codes used by commercial organisations and achieved an average performance improvement over the whole application of 2.25, i.e. on average we more than halved the time to solution. As well as reducing run-times, greater efficiency can also lead to reduced power consumption or cloud computing costs. POP provides performance optimisation and productivity services for codes in all domain. POP has the tools and expertise to analyse all aspects of performance from single processor efficiency to the scalability of large parallel codes. We work with programs written in most languages and parallel paradigms, including MPI, OpenMP, CUDA, OpenCL and OpenACC. We will review examples of performance assessment for engineering codes and improvements made so far. We will highlight some of the open source profiling tools used within the project and give details as to how the POP service can be utilized. References [1] The POP Website. https://pop-coe.eu/ [2] The POP Partners are Barcelona Supercomputer Center, High Performance Computing Center Stuttgart, IT4Innovations National Supercomputing Center, JÃ¼lich Supercomputing Centre (JSC), The Numerical Algorithms Group Ltd, Rheinisch-WestfÃ¤lische Technische Hochschule Aachen, Teratec, LI-PaRAD Laboratory UVSQ. https://pop-coe.eu/partners

Speaker Biography:

Dr. FouzhanHosseini is an HPC application analyst at NAG. She has over 10 years of experience in building parallel applications on various platforms from multi- and many-core hardware to computer clusters exploiting low- to high-level programming technologies where performance always appears as a key part of the work. With a strong background in computer science, she is passionate about promoting best practices in parallel programming and supporting HPC users to improve the performance of their codes. Before joining NAG, she had various research and teaching positions at the University of Leeds, UK, the IstitutoItaliano di Tecnologia, Italy, and the University of Tehran, Iran. She is Chair of the NAG Women in HPC (WHPC) Chapter and advocates for diversity and inclusion at work.

Presenter Name: Wolf, Klaus

Presenter Company: Fraunhofer SCAI

Presentation Title: VMAP Enabling Interoperability in Integrated CAE Simulation Work Flows

Session Title: 7C Innovative Applications

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 4:15 PM

Keywords:

Abstract:

Speaker Biography:

Not Provided

Presenter Name: Enzer, Mark

Presenter Company: Mott MacDonald Limited

Presentation Title: The National Digital Twin

Session Title: Keynote: Day 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 09:40 AM

Keywords:

Abstract:

The National Digital Twin (NDT) is a big idea that promises enormous value for the people of the UK, both in the delivery of new assets and in the performance of our existing infrastructure. The NDT is not one massive model of everything, but an ecosystem of connected digital twins. And connecting digital twins is all about interoperability - enabling secure resilient data sharing across organisational and sector boundaries, but this requires data consistency that the market alone cannot initiate; it requires government-level leadership to set the rules for the industry. Making better decisions is central to the vision for the NDT because better decisions, based on better data, lead to better outcomes for people, which is the essential promise of the Information Age. This presentation will: introduce the National Digital Twin, explain what it is and why we need it, and outline what is being done to deliver it.

Speaker Biography:

Mark is a keen champion of innovation in the context of collaborative delivery models and in particularly transformational change in the infrastructure industry (including: the application of: Digital Transformation, Smart Infrastructure, connected digital twins, low-carbon sustainable solutions; platform-based delivery, BIM and DfMA). As Mott MacDonald's Chief Technical Officer, Mark is accountable to the Executive Board for technical excellence across the Group. As the Chair of Centre for Digital Built Britain (CDBB) Digital Framework Task Group, Mark is contributing to the leadership of the National Digital Twin Programme. https://www.cdbb.cam.ac.uk/ . Mark was the Digital Transformation workstream lead as part of Project 13 for the Infrastructure Client Group and he was the lead author of the Infrastructure Carbon Review, published by HM Treasury.

Presenter Name: Foale, Michael

Presenter Company: ISSET

Presentation Title: Saving the Russian Mir Space Station : The Role of Computerised Simulation

Session Title: Keynote: Day 1

Presentation Date & Time (*GMT; London*): 11/9/2020 @ 1:30 PM

Keywords:

Abstract:

Michael will take the audience through being assigned to the Russian Space Agency, his training in Russia and returning to Houston to launch the Mir. This will be followed by life on the Mir, the collision (the worst space accident in history), saving the space station and his use of computer simulation.

Speaker Biography:

Mike was the first British-born NASA Astronaut and has been into space on 6 missions. His experience includes; being Commander of the International Space Station, bringing the Hubble Space Telescope back to life and having a major role in saving the Russian 'Mir' Space Station as it tumbled out of control around the Earth, following the only collision in outer-space. He has had a range of senior roles in NASA that include having been the Deputy Administrator at NASA HQ, Chief of the Astronaut Office Expedition Corps and Assistant Director of the Johnson Space Centre. Mike held the record for the number of days spent in space.

Presenter Name: Keskin, Akin

Presenter Company: Rolls-Royce Group PLC

Presentation Title: Innovation through Engineering Simulation - A Rolls-Royce Perspective

Session Title: Keynote: Day 2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 9:45 AM

Keywords:

Abstract:

Speaker Biography:

Akin holds a degree in Aerospace Engineering from the Technical University of Berlin in Germany and a PhD in Mechanical Engineering from the Cottbus University in Germany. He lectured Compressor Aerodynamics and High-Speed Aerodynamics in Berlin and Cottbus. Akin joined Rolls-Royce Deutschland in 2001 as a CFD Methods Development Engineer and continued his career as a Compressor Aerodynamicist before moving to the UK and leading multiple high profile simulation and modelling capability development projects on improved component lifing, CFD modelling, thermo-mechanical and structural modelling. Akin has been appointed to an Engineering Associate Fellow in Design Systems and Methodologies in 2015 and is currently Global Capability Lead in Design Systems within the Rolls-Royce Group. He has extensive experience in leading and contributing to German, UK and European funded research projects. Akin is an active member of the AIAA and ASME with more than 30+ publications, is regular keynote speaker and panelist at various international conferences and workshops, member of the IGTI Executive Committee and the ATI Specialist Advisory Group.

Presenter Name: Pope, Victoria

Presenter Company: University College London.

Presentation Title: Climate change – How Can Climate Models Help us to Respond?

Session Title: Keynote: Day 2

Presentation Date & Time (*GMT; London*): 11/10/2020 @ 9:00 AM

Keywords:

Abstract:

Numerical models to simulate the weather were one of the first practical uses of high-performance computing. Today, the descendants of these models are used to make decisions every day affecting our social and economic well-being, as well as safety critical activities. The climate versions of these models are being used to make important choices about how much we need to reduce greenhouse gas emissions and what trade-offs there are likely to be between adapting to and mitigating the impacts of climate change. They have profound implications for the decisions that we make about future energy supply and other economic and technological development. One of the key challenges is to understand the complex trade-offs between solutions. We must look at the complete cost of solutions over their lifetimes and all the aspects of the impacts, not just climate change. This is the challenge for scientists and engineers as well as policymakers, and we must take a much more multidisciplinary approach. This talk will provide a brief introduction to climate modelling and future challenges. These span science, technology, policy and will embrace new ways of working. Examples include: 1. The complex linkages between problems, e.g. Air quality and climate change, food supply and biofuels, 2. Improvements in technology and data science allowing innovation in usability and availability of data 3. The breakdown in the exponential growth of computing power (Moores law).

Speaker Biography:

Vicky Pope had a long and varied career in the Met Office. She worked for many years on climate change, leading climate model development, the wider climate programme and acting as the public face of the programme. In her last role she was Head of Science and Technology Futures and member of the Met Office Government Services Senior Management Board. Vicky is Independent Chair of MEI (Mathematics in Education and Industry), a Trustee of BRE Trust (the Building REasearch Establishment), the Devon Wildlife Trust and In2ScienceUK. She is also the National Labs lead for the Association of Research Innovation and Technology Organisations (AIRTO) and a member of the EPSRC Mathematics Science Advisory Team. She is also an honorary professor at UCL.