NAFEMS UK Regional Conference 2018 - Abstract Submission

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Please identify the event for which your submitting?	NAFEMS UK Conference 2018
Will you be the presenting author?	Yes
Presentation Title	In Support of the Digital Twin: A Geometric Paradigm to Model Performance Degradation and Assess System Robustness
Relevant Themes / Keywords	Digital twin, High fidelity, massively parallel

Abstract (plain text)	The role of a Digital Twin is to represent a system, in this particular case a gas turbine, over its whole life from design through manufacturing, service, overhaul & maintenance with data-driven feedback throughout to improve the economic and environmental performance of the system. The great majority of design and analysis effort is conducted using the ‘pristine’, ‘nominal’ or ‘asmanufactured-intent’ representation of components and hence, by extension, assemblies and complex systems. Although this approach is extremely useful is guiding towards ‘better’ designs, it does nothing to advance the knowledge of performance as time passes for the real machine in the field. Information of this type is typically gathered by sensors or inspection and is always after-the-event and reactive rather than predictive and pro-active. A major obstacle to predictive analysis of the effects of wear, degradation, soiling and other effects which alter the components from the pristine condition is that the geometric model traditionally used to create, develop, track and audit component design – i.e. solid kernel B-REP based CAD - is unsuitable for representing the chaotic, non-linear, organic, time-dependent changes which arise from real-world usage. In this presentation we show that using a digital, spacial occupancy representation of the geometry, stored as a distance field on an automatically refined Octree grid allows us to seamlessly morph the geometry between end-states (pristine and maximum wear) to capture all the time-history of the wear patterns and subsequently deliver this newly generated intermediate state as a volume discretised mesh suitable for numerical analysis – be that fluid dynamics, structural, thermal or a conjugate of all three. Analysis is then carried out and an assessment of component robustness (variation of performance over time) can be made. Geometry morph, mesh, pre-processing, analysis and post-processing take place within a fully automated control structure. Moreover, the model is impervious to large variations in scale, can be of arbitrary complexity and can be added to or augmented by additional components, systems and sub-systems to build up the most comprehensive representation of the real-world installation. This all-encompassing approach, modelling real world effects in a responsive and timely manner, is commonly known as the ‘Digital Twin’. In this presentation we demonstrate that the Digital Twin, supported by our implementation of a digital geometry representation has the potential to significantly enhance the simulation and prediction of in-service performance variation. This, in turn, allows engineers to gain a better and more nuanced understanding of component, assembly and system robustness which drives cost savings across all engineering business sectors
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