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	Computer Learning in Automated Manufacturing Processes: Control of Resin Infusion Using a Digital Twin
Relevant Themes / Keywords	Infusion, process simulation, digital twin, machine learning, digital manufacturing, Manufacturing process simulation

Abstract (plain text)	There is a clear industrial move towards out-of-autoclave composite manufacturing techniques; resin infusion is a process frequently used in the renewable energy sector and is becoming increasingly popular in aerospace and automotive environments. Typical methods of process optimisation for infusions tend to rely on either physical trial and error or process simulation using finite element analysis, neither of which in isolation can account for case-by-case variability to reliably prevent the formation of dry spot and racetrack defects. In collaboration with the Centre for Modelling and Simulation (CFMS), the National Composite Centre (NCC) has demonstrated the ability to detect and control defect formation during the infusion process using machine learning. A virtual “design-of-experiments” of the manufacturing process has been conducted, resulting in the generation of over 15,000 manufacturing simulations of a liquid composite resin infusion process. Following the modelling, machine learning techniques have been used to process the simulation data and classify the decisions made during the infusion process to minimise the formation of defects. In the physical manufacturing process, the flow of resin is monitored using intelligently positioned dielectric sensors, enabling a real-time understanding of the flow inside a closed mould. The machine learning model developed from the virtual manufacturing simulations is used to predict and mitigate the formation of defects in real time by selectively opening and closing injection and vent valves. The manufacturing process is run alongside the machine learning model, which takes real-time information on the resin flow front from the dielectric sensors. Using the flow data, the model is able to predict the likelihood of defect formation, and is able to instruct the system to make adjustments necessary to produce a laminate defect free. This pilot project acts as a proof-of-principle for the application of machine learning to provide in-process control of a composite manufacturing process. It will reduce the need for rework, scrap, or repair, ultimately saving manufacturing costs of composite components. It has the potential to be upscaled to complex composite part geometries for industries including aerospace, automotive and renewables.
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