Queen's Doctoral Training Programme on
Secure Connected Intelligent Design and Manufacturing

Title: DTP: Geometric Inclusion of Coatings / Sealants in an Enhanced DMU for Improved Precision in Assembly Planning.

This project is part of the Queen's Doctoral Training Programme in Secure Connected Intelligent Design and Manufacturing. Many of today's industrial approaches require transformative changes to ensure long term societal, economic and environmental resilience and sustainability. PhD projects in this programme explore the potential of emerging digital technologies, such as artificial intelligence, robotics, and the Internet of Things, to transform the way we design, manufacture and operate products and services.

Project description:
The aim of this project is to improve design and manufacturing based integration through an enhanced digital mock-up (DMU) to enable a better understanding of how coatings / sealants affect assemblability.

Current DMUs and Product Lifecycle Management (PLM) systems are based on individual, nominally sized components in an assembly, positioned so that they appear to be in the correct location relative to other parts in the product. Despite improvements in computational power, design software capability and graphics processing, coatings / sealants are not included in the modelling environment making their contribution to assembly planning difficult to account for accurately. Consequently, this limits a DMU's use to the broad understanding of component positional relationships. Current DMUs lack the precision to account for the impact of coatings / sealants on tolerance stack ups for high precision applications. The absence of CAD geometry which is representative of 'as manufactured' dimensions as a design evolves, means that investigations into the effects of manufacturing capabilities are limited. As product development approaches production without full validation of the assembly, problems can arise during manufacture as coated components and sealed assemblies differ from their assumed nominal forms.

This work seeks to create an enhanced DMU that enables the generation of geometric representations of coatings / sealants in the CAD domain. This will subsequently enable the generation and exploitation of enhanced tolerance information related to manufacturing capabilities through the creation of coatings / sealant entities which co-exist with the nominal part definition within a PLM framework. Improved precision in the DMU will ultimately improve accuracy / precision of downstream PLM simulation tools used for automation planning and robotic configuration. This will ultimately provide the digital utility required for manufacturing planning within a cyber-physical framework.

Aims and Objectives:

Aim: Enrich the DMU to include coatings / sealants enabling enhanced process capability definition and leading to the development of a tool for design and manufacturing integration through the automatic creation of manufacturing analysis models.

Objectives:

1. Develop a methodology to integrate design and manufacturing disciplines using an enhanced DMU.
2. Explore computer aided design capabilities to determine the functions for assembly analysis and identify any limitations.
3. Incorporate 3D tolerances (dimensional / geometric) during component modelling to allow for more realistic product definition.
4. Use these enhanced product models to create the DMU.
5. Create an interactive CAD based environment with visual / quantitative feedback to drive manufacturing decisions related to the geometric inclusion of coatings / sealants, for example, selecting new/optimal tolerance conditions based on DMU data.
6. Produce a set of technology demonstrators as case studies to verify the integrated design and manufacturing methodology.
7. Use the Enhanced DMU in simulations of assembly
8. Derive / obtain metrics from these simulations for advanced process capability definitions
9. Validate these virtual builds with actual builds in real life examples

Key skills required for the post: Applicants must have a degree in Mechanical or Aerospace engineering, or an equivalent qualification at Masters level. Candidates should be able to demonstrate that they are highly motivated, have excellent communication skills, be able to work in a team and undertake challenging tasks using their own initiative. Any academic or industrial experience relevant to manufacturing, engineering modelling or programming would be advantageous, but is not essential.
Key transferable skills that will be developed during the PhD: The programme offers a bespoke research and training programme that aims to develop students into cross-disciplinary, industry-conscious thinkers and leaders who will influence the roadmaps of future advanced manufacturing technologies and their applications. They will have a balanced understanding of computer aided engineering in the context of their application to Advanced Manufacturing and High Value Design.

Lead supervisor:	Dr Joe Butterfield, SMAE, j.butterfield@qub.ac.uk
Other supervisor(s):	Dr John McAllister, EEECS, jp.mcallister@qub.ac.uk Dr Trevor Robinson, SMAE, t.robinson@qub.ac.uk Prof. Adrian Murphy, SMAE, a.murphy@qub.ac.uk
Guaranteed stipend:	This is a 3.5 year funded Queen's DfE DTPs studentship with Training Grant, to commence on 1 October 2020 (N.B. stipend for 20/21 is not yet known, but is likely to exceed £15,000). The studentship covers fees and maintenance and is available for UK residents (see full eligibility criteria - nationality, residency, and academic qualification at: http://go.qub.ac.uk/dfeterms). **When applying using the Queen's portal please ensure you include "DTP:" along with the project title.**
Conditional top-up available:	

PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.#

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.