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

Title: DTP: Future factory digital design

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:
Future factories must be sustainable, agile and flexible in their operations to provide on-demand manufacturing capabilities, near the end consumer, enabling mass customization, adapting quickly with changing market needs and production technological developments. As a consequence and unlike traditional production systems which needed high volumes of identical units to be efficient, future factories need to be economically, environmentally, and socially sustainable with small batches but with high levels of product variation. Much of the future developments in factories will rely on cyber-physical systems, where computation, networking, and physical processes are intensely integrated. A key characteristic of such cyber-physical systems is the data feedback loops where the physical processes affect computations and vice versa, enabling much of their advantage over traditional fixed processes, static factory arrangements and set operational controls. This is branded as the fourth industrial revolution and is expected to create up to $3.7 trillion in value to global manufacturing [2020 World Economic Forum].

However tools to conceive, design, implement and operate such future factories are not available today. Current predictive modelling technologies can be used for the development, evaluation and optimisation of today's fixed production facilities with traditional control mechanisms. However, predictive modelling technologies are without established strategies to represent the cyber-physical data loops expected in future processes. Nor are today's modelling approaches conceived or capable of effectively representing the flexibility in factory operations envisaged for the future, with continuously evolving product details, processes and demand. Thus a new generation of predictive modelling methods and tools are required to enable the fourth industrial revolution.

Aims and Objectives:
The aim of this project is to develop, and demonstrate on realistic industrial production problems, predictive modelling strategies to design cyber-physical feedback loops in future processes and factories, and quantify their performance. The project will specifically focus on developing modelling capability to include advanced data acquisition in the production environment along with data and control strategies which regulate not only resource and material flow but also the configuration of the production system.

- Review available modelling technologies used for the design and optimisation of production processes and factories; review physical and cyber technologies envisaged for future production processes and factories.
- Based on the preceding review create a project hierarchical database of production design problems which characterise future factory visions, to include a series of varying complexity value chains.
- Using the available suite of modelling technologies undertake a series of systematic modelling studies, focused on the hierarchical database of problems, establishing and quantifying the key modelling challenges associated with the design and optimisation of cyber-physical manufacturing solutions.
- Formulate and develop modelling strategies to address the critical challenges associated with representing both physical and cyber data streams, and propose modelling architecture to enable data from physical monitoring and data from simulation predictions to be used as part of new manufacturing control strategies.
- Again using the hierarchical database establish and demonstrate the utility of the proposed modelling strategies, capturing the relationships between the new control strategies and the physical behaviour witnessed within the production environment, quantifying the benefits of any proposed modelling strategies by benchmarking against current state of the art, and the associated new data requirements and computational burden.
- Write-up thesis and final journal papers.

Key skills required for the post: A minimum 2.1 honours degree or equivalent in Engineering (Electrical and Electronics, Mechanical, Aerospace, Manufacturing) or Computer Science/Software Engineering, or other relevant discipline.	
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 ICT (security, communications and data analytics) in the context of their application to Advanced Manufacturing and High Value Design.	
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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:	A top up may be available for an exceptional candidate, dependant on the recommendation of the interview panel and industrial sponsor.
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.