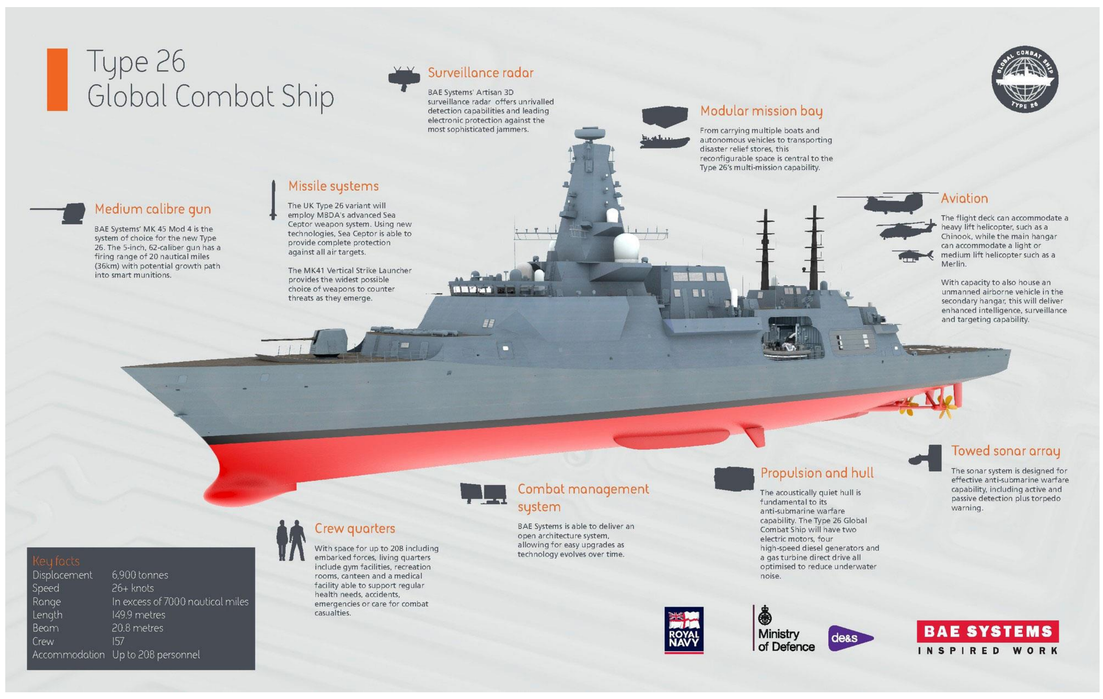
Advanced Digital Manufacturing Techniques for Complex Warships

Sebastian Froehlich[1], Robert Whitfield[2], Douglas Roy[3], Jon Count[4]

1- DMEM, University of Strathclyde, Glasgow, sebastian.froehlich@strath.ac.uk
2- DMEM, University of Strathclyde, Glasgow, ian.whitfield@strath.ac.uk
3- BAE Systems Maritime Naval Ships, Scotstoun, R&T department, douglas.roy@baesystems.com
4- BAE Systems Maritime Naval Ships, Govan, M&E function, jon.count@baesystems.com

1. Project Description

This PhD will deliver an Architectural Framework for applying Industry 4.0 manufacturing techniques and technologies. This research aims to assist the transition of methods used to manufacture, build and construct State-of-Art complex Naval Ships. It will provide guidance on the critical factors for consideration in practice and encourage modern manufacturing techniques and technologies that fall under the Industry 4.0 umbrella.
The need for this transformation is due to ship-building being a traditionally conservative industrial sector; however, with the rapid innovation in manufacturing techniques, the approach to manufacturing Naval Ships must also change.
Industry 4.0 encourages enhanced and digitally enabled data-driven manufacturing processes and operations across Naval Ships production lines of BAE Systems Maritime Naval Ships (MNS). The scope of work of this research is directly aligned with the UK's Industrial and High-Value Manufacturing strategies.

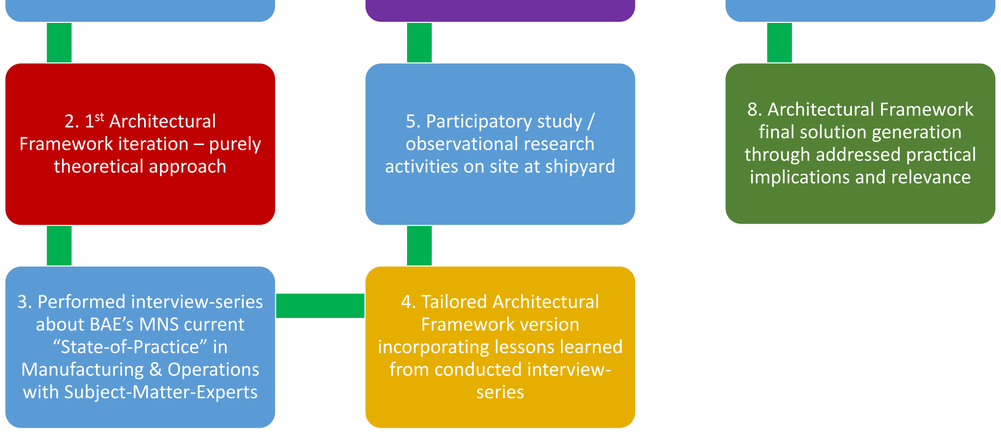


Naval shipbuilding is usually referred to as a process called ETO (Engineering-To-Order), which normally results in a lot of rework and duplication due to the nature of the ETO process itself. In order to better streamline production and achieve enhanced data-driven manufacturing procedures and operations regarding the ETO, the envisioned advanced digital manufacturing techniques and technologies considered for the Architectural Framework are as follows:

1) Additive Manufacturing (3D-/4D Printing)
2) Augmented Reality (AR)
3) Automated Simulation (Digital Twin)
4) Big Data Analysis
5) Cloud Computing
6) Cyber Security
7) Intelligent Robotics / Cobots
8) Internet of Things (IoT) / Internet of Services (IoS)

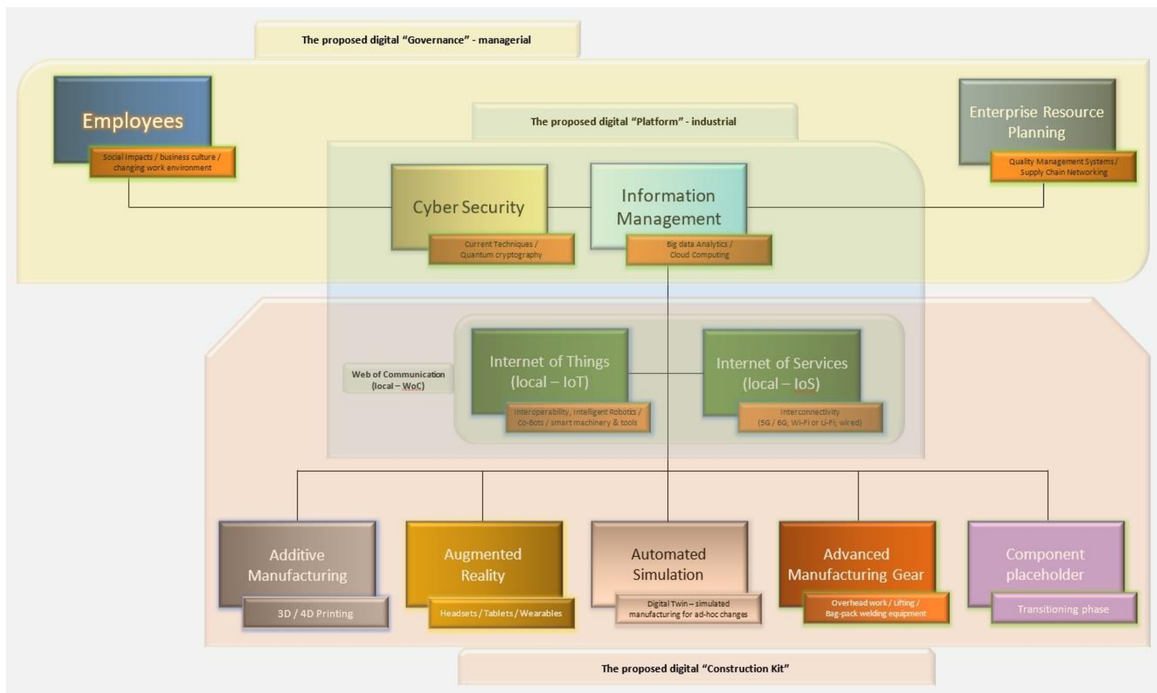
2. Process of solution generation for practical relevance

The environment of ETO manufacturing is a diverse field of applications that must work in concert to accomplish a desired outcome. Thus, for a researcher a mixed approach and investigation to gather the relevant theoretical as well as practical data is of paramount concern in addressing the subsequent critical points of interest for a digital shipyard.



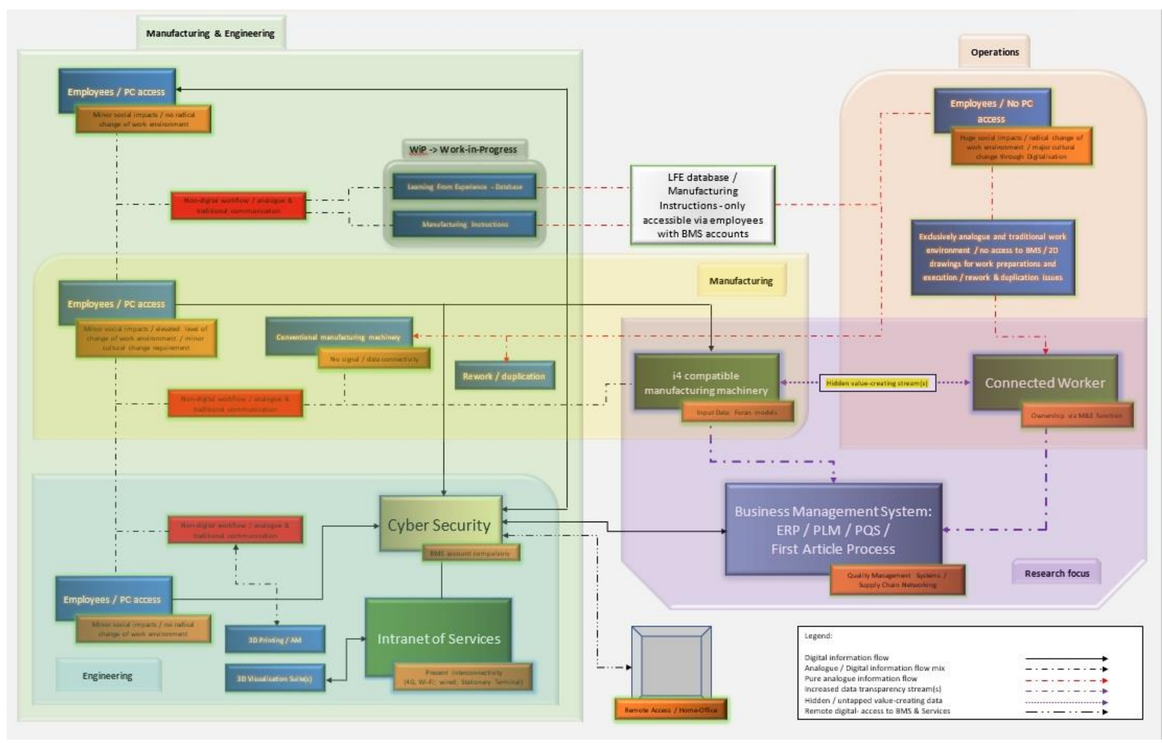
3. Architectural Framework (theoretical)

The fundamental goal is to enable BAE Systems Maritime Naval Ships (MNS) domain for its manufacturing facilities & operations to achieve an improved digital information flux in its fabrication processes.
This, in order to be able to achieve ***interconnectivity*** as well as ***interoperability*** throughout digital manufacturing information exchanges between employees and smart machinery in real-time.
Ultimately, to design a concept for introducing a modern ***CPPS*** (Cyber-Physical Production System) to improve today's value-creating streams in Naval Shipbuilding.



4. Depiction of the tailored Architectural Framework

The tailored Architectural Framework incorporates all the lessons learned from the conducted interview-series with BAE Systems Subject-Matter-Experts. The current ETO manufacturing environment requires further investigation that is outlined in the purple box, called "Research focus".
The implementation of advanced digital manufacturing techniques and technologies demands signal networking capability, today achieved through the Industrial IoT architecture for digital IoT communication applications. Furthermore, data utilisation requires the establishment of Industry 4.0 & Cyber-Physical System(s) – CPS – in order to orchestrate a more data transparent manufacturing stream.
Therefore, the challenges ahead are focussing predominantly on analogue to digital interfaces within traditional production flows nowadays.



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