



Consultancy Project Report

BABCOCK INTERNATIONAL GROUP

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EXECUTIVE SUMMARY

This project report presents a comprehensive analysis and strategic recommendations to align cock's product and service portfolio with global trends, societal shifts, and sustainability commitments. The project followed a structured approach, comprising several key phases:

1. **Global Trends Analysis:** Employing Porter's Five Forces, PESTEL, and SWOT analyses, we examined macro and microenvironments. This highlighted trends like supply chain transparency, circular economy principles, and increased renewable investments.
2. **Portfolio Evaluation:** Babcock's offerings were rigorously examined considering these trends. Opportunities for expansion and innovation were identified, emphasizing Industry 4.0, WHR, hybrid electrification, and Bio LNG potential. At the same time, we've outlined an opportunity for the company to make tangible social impact through a serving veterans initiative.
3. **Strategic Recommendations and Framework:** Actionable recommendations and a strategic framework were developed, encompassing ADKAR model integration, an implementation timeline, risk assessment, and visioning the ecosystem. These measures enable Babcock to navigate sustainability changes, seize market opportunities, and address potential challenges while maintaining a clear future vision.

1. INTRODUCTION

1.1 PURPOSE

This project aims to evaluate the future of Babcock's products and services considering technology, consumer behaviour, and market dynamics changes and the company's commitment to reducing carbon emissions and creating social value.

In light of substantial challenges concerning carbon emissions and social responsibility (Martin, 2023.), Babcock has decided to evaluate its array of products and services while taking into account these transformative dynamics when making informed decisions about future offerings.

1.2 SCOPE

This project focuses on Babcock's core business areas: Aviation, Marine, and Land. Due to data limitations, the nuclear sector is excluded. The primary focus is on fulfilling the sustainability goals of key customers, such as the UK government and MOD (Babcock International Group, 2023).

1.3 OBJECTIVE

1. Conduct a comprehensive review of global trends and developments, including changes in technology, consumer behaviour, and market dynamics.
2. Evaluate the company's current products and services portfolio and identify areas for new markets, potential growth, and innovation considering societal changes, emerging trends, and customer needs.
3. Develop recommendations and a framework or visualisation for the company to align its products and services offering with areas of growth, societal changes, and the company's commitments to addressing climate change and sustainable development.

2. RESEARCH & BENCHMARKING

2.1 KEY GLOBAL TRENDS IMPACTING THE A&D INDUSTRY

The aerospace and defence sector are evolving rapidly despite the pandemic's impact, it has shown resilience with revenue growth and increased profits. (PwC, 2023). The following sections explore these shaping trends in the sector.

Focus On Supply Chain Visibility and Resilience:

The A&D industry grapples with supply chain disruptions from COVID-19, workforce shortages, and geopolitical events like the Ukraine conflict. To address these concerns, companies are emphasizing supply chain diversification, local sourcing, and nearshoring, aiming to enhance visibility and coordination across the entire supply chain. (Deloitte, 2023; Lockheed Martin Q2 Reports, 2022)

Acceleration Of Digital Thread and Smart Factory:

To address potential disruptions, A&D firms embrace agility via the 'digital thread,' fostering connectivity across their operations. They employ advanced tech like cloud, big data, AI/ML, digital twins, and IoT, as seen in a leading aircraft engine manufacturer's digitization effort (Richardson, 2020).

In 2023, A&D firms are set to implement 'smart factory' strategies for enhanced agility, reducing lead times, optimizing cycle times, and boosting overall factory efficiency (Deloitte, 2023).

Prevalence Of Unmanned Warfare:

Deloitte predicts a significant year for the advanced air mobility (AAM) market, with eVTOL aircraft companies making strides in technology and regulations. Ukraine conflict has reshaped aerial warfare dynamics. Both nations now rely less on manned aircraft (PwC, 2023). The UK is embracing drones, with the International Trade Administration expecting widespread usage by 2030. Notably, the UK Ministry of Defence awarded Lockheed Martin a 129-million-pound contract for advanced mini drones (Ministry of Defence, 2022).

Aging Workforce and Skill Shortages:

Automation and digital technologies are reshaping the industry, requiring advanced skills in aerospace engineering and digital domains (Deloitte, 2023). Labor shortages among top A&D companies are amplifying supply chain issues and impacting revenue targets for 2022 due to slower factory output (Cameron, 2022). Engineer shortages, prevalent for a decade, have been exacerbated by events like the Ukraine invasion, affecting defence sector responses and escalating costs (Deloitte, 2023).

Investments In Renewable Energy:

Studies indicate that businesses and funds adhering to ESG principles are linked to financial out performance and stronger stock prices (Dimitrova et al., 2021). The UK government and the Ministry of Defence have set sustainable development objectives, fostering investments in clean energy (UK Government, 2021; UK Ministry of Defence, 2021). The demand for renewable energy has been steadily increasing in the UK from 2015 to 2023, with growth projected to continue until 2025 (Statista, 2023).



Circular Economic Thinking:

Europe's shift to a circular economy could yield up to EUR 1.8 trillion by 2030. Funds focusing on circular economy principles are growing. Industry leaders like Renault and Philips are already implementing circular practices, offering remanufactured components, and witnessing positive outcomes (Ellen MacArthur Foundation, 2020). The UK MOD recognizes circular economy principles' role in decarbonizing the defence sector, aligning with the country's Net Zero commitment by 2050 (UK Ministry of Defence, 2021)

2.2 BENCHMARKING- KEY MARKET PLAYERS AND COMPETITION SYNOPSIS

Currently, Babcock operates in warships, MRO, asset management, emergency services, and defence training sectors. Competitors in the defence sector like BAE Systems, Boeing, Thales, and Lockheed Martin offer unique products and services not currently provided by Babcock.

Product and service offerings: -

<div>BAE SYSTEMS</div> <ul style="list-style-type: none">• <i>Warships</i>• <i>Carrier Strike Groups</i>• ACVS• <i>Artillery & Precision Systems</i>• <i>UAV</i>• <i>Fighter Jets</i>• <i>Trainer</i>• <i>Aircrafts</i>	<div></div> <ul style="list-style-type: none">• <i>MRO and Asset Management</i>• <i>Cyber Security</i>• <i>UAV</i>• <i>Fighter Jets</i>• <i>Maritime patrol aircraft</i>
<div>THALES</div> <ul style="list-style-type: none">• <i>Asset Management</i>• <i>Investment In R&D</i>• <i>Augmented Soldier</i>• <i>Fighter Jets</i>• <i>Tactical Aircrafts</i>• <i>Cargo Planes</i>• <i>UAV</i>• <i>Cyber Security</i>	<div>LOCKHEED MARTIN </div> <ul style="list-style-type: none">• <i>Asset Management</i>• <i>AR War Training</i>• <i>Fighter Jets</i>• <i>Tactical Aircrafts</i>• <i>Cargo Planes</i>• <i>UAV</i>

Tab 1: Competitor Capabilities

BAE Systems excels in adaptable amphibious combat vehicles, while Boeing's P-8A Poseidon is a versatile maritime patrol aircraft. Thales focuses on enhancing soldier capabilities through advanced technologies, and Lockheed Martin's WAR Training System improves Joint Terminal Attack Controllers' skills in safe, immersive environments (BAE Systems | United Kingdom,2023.; Boeing, 2023; Polytechnique Insights, 2022; Lockheed Martin, 2023.;). These unique offerings present diversification opportunities for Babcock.

Similarities:

In the aviation sector, these companies are aligned in manufacturing UAVs, fighter jets, cyber security solutions, and tactical aircraft. Military drones are used for intelligence gathering, offering cost-effective precision compared to traditional weapons (Future, 2023).

2.3 PESTLE ANALYSIS: NAVIGATING GLOBAL TRENDS

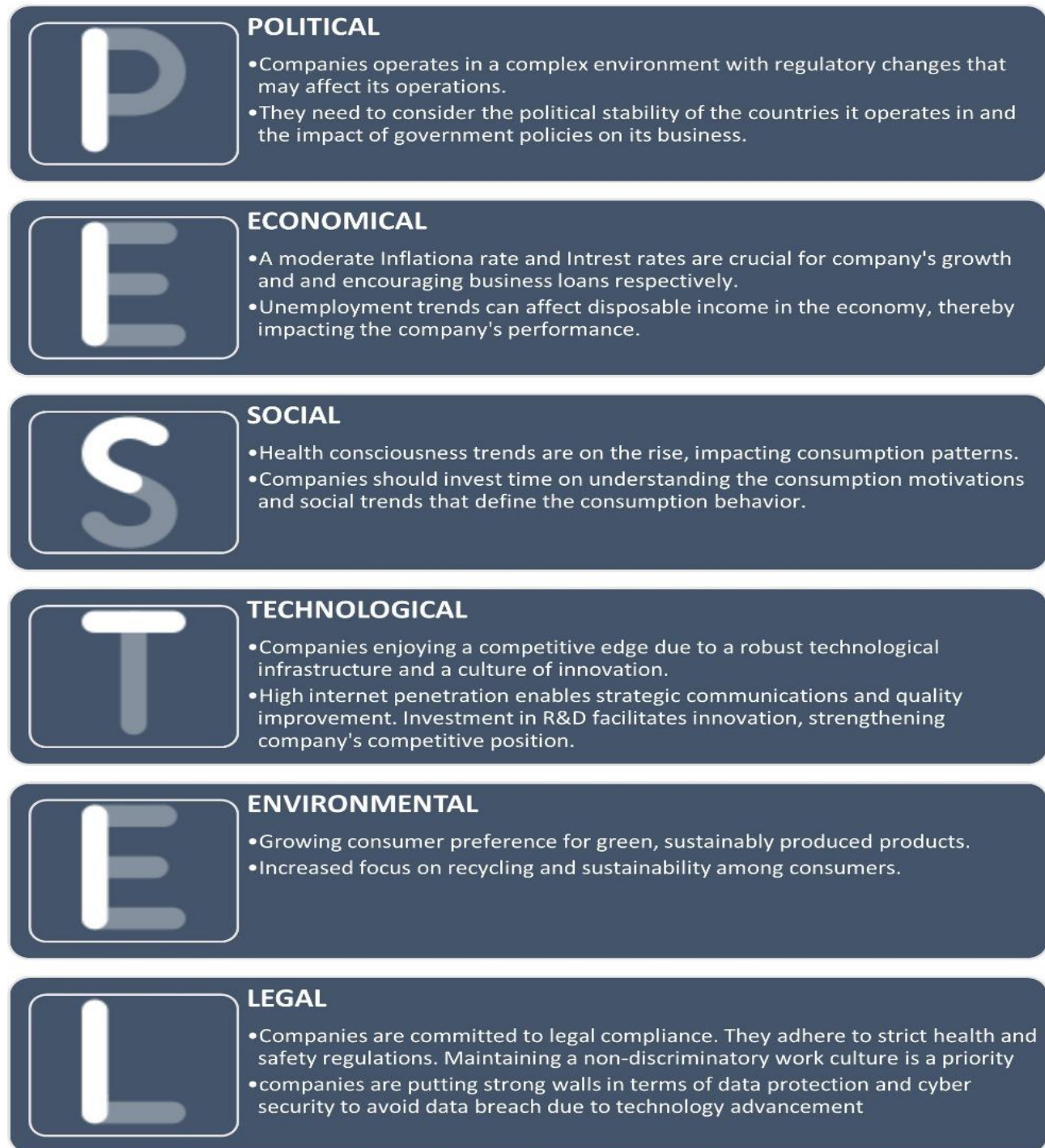


Fig 1: Pestle Analysis

Babcock international must navigate global trends. (Defence engage,2023.) Adapting to regulations, embracing sustainability, and leveraging technology are vital. Monitoring international inflation, interest rates, and consumer preferences is key. Strengthening

cybersecurity is essential against technological shifts (www.techuk.org, 2023). Proactive response positions Babcock as a resilient leader.

2.4 PORTER'S FIVE FORCES: ANALYSING INDUSTRY DYNAMICS

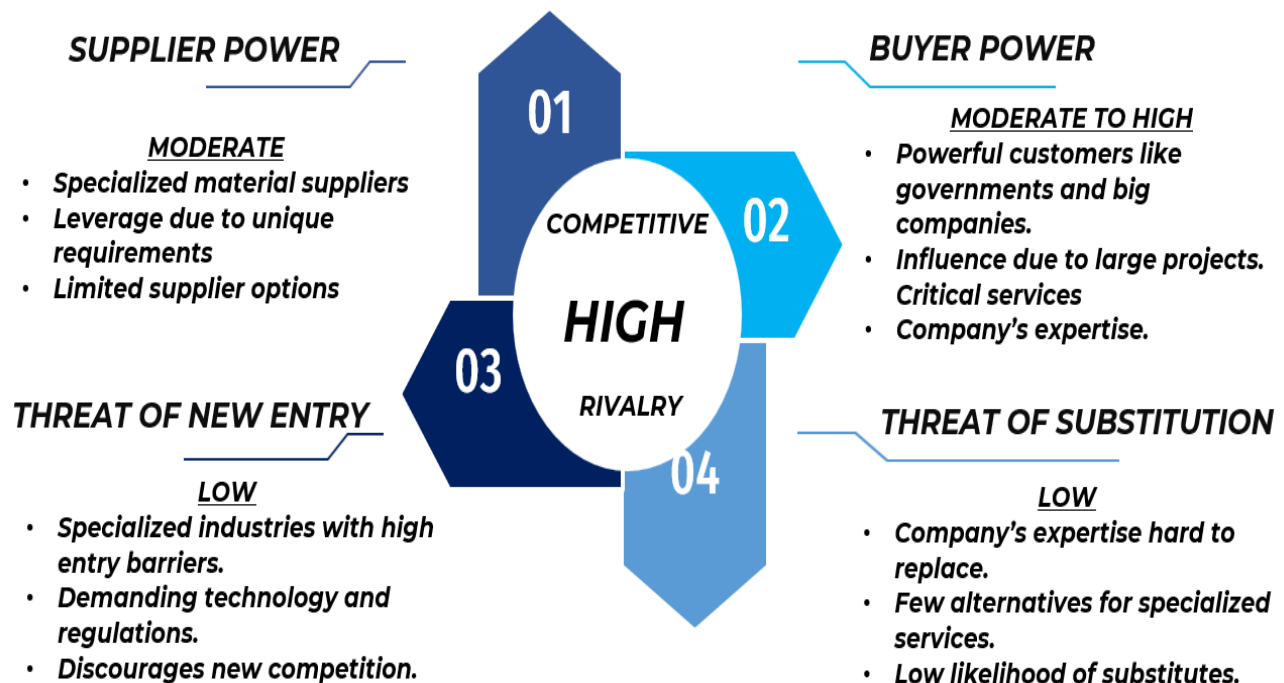


Fig 2: Porters Five Forces

Babcock international should leverage its reputation and expertise to manage varying buyer power and supplier relationships effectively. it should focus on innovation, differentiation, and strategic alliances to counter highly competitive rivalry and low threat of new entry. global expansion and continuous market intelligence will be key to sustained success (Fern Fort University, 2018.)

3. EVALUATION & DEVELOPMENT PROCESS

3.1 INTERNAL ANALYSIS OF BABCOCK: STRATEGIC ARENA ASSESSMENT

Using a graph of business strength against arena attractiveness, we assessed Babcock's presence in key sectors. Our assessment considered factors such as defence spending forecasts, contract duration, extension possibilities, and GDP size. A general guideline applied: the higher the defence spending forecast relative to GDP and the longer the contract, the stronger Babcock's position.

Key insights revealed that the UK boasts the largest GDP among the nations where Babcock operates (NationMaster, 2023) and has awarded Babcock some of the lengthiest contracts (Babcock Presentation of Results, 2023). These factors collectively position the UK defence market as an exceptionally attractive arena and a stronghold for Babcock. In 2023, it contributed £4 billion in revenue, constituting 67% of Babcock's revenue structure (Babcock Presentation of Results, 2023).

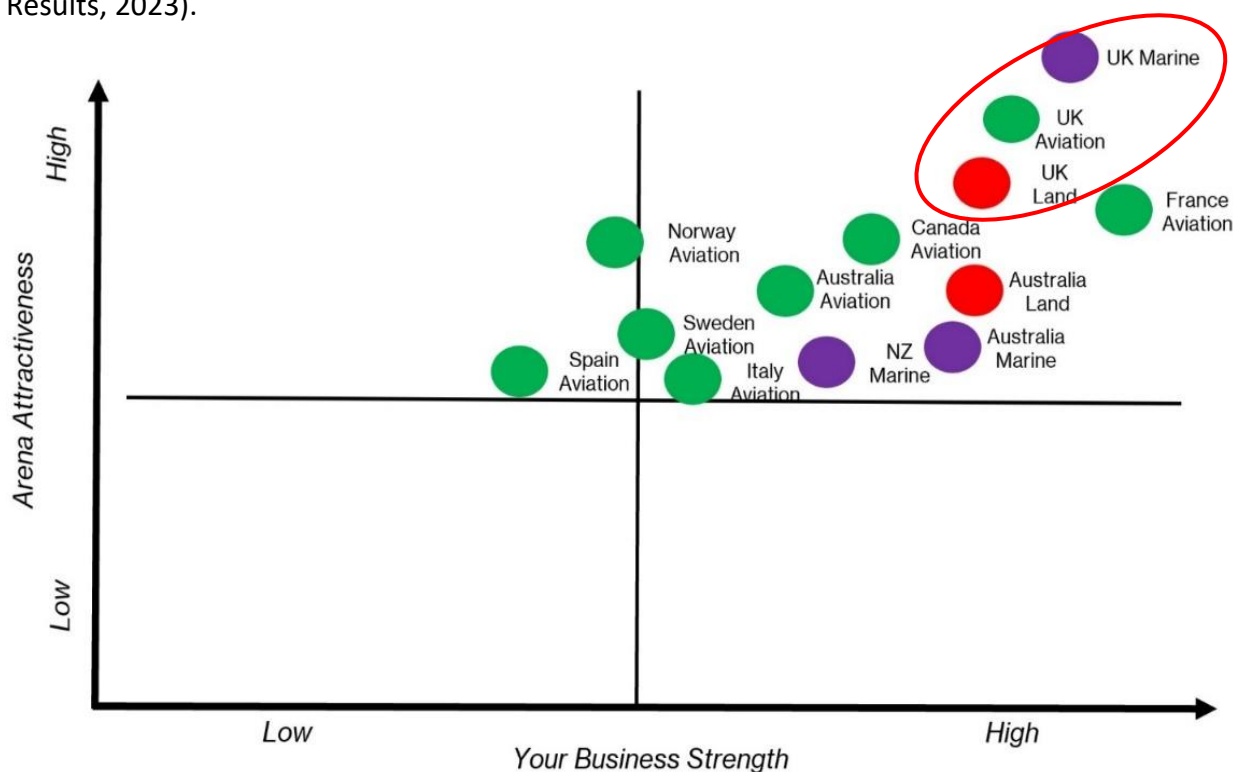


Fig 3: Graph Evaluating Babcock's Business Strength

3.2 EVALUATING BABCOCK'S KEY SUSTAINABILITY INITIATIVES AND NET ZERO GOALS

Babcock’s significant sustainability initiatives were also brought under consideration including the Go zero partnership from the project Monet initiative, data driven scheduling initiative for touring pilots, the Plan Zero 40 strategy for decarbonization, biodiversity initiative for maintaining and enhancing estate biodiversity, the electrification of Babcock facilities using renewable energy sources, the water and waste management plans and finally the zero waste to landfill initiative.

Assessed against Dunphy's levels of engagement (Dunphy et al., 2012), Babcock's sustainability measures, coupled with its focus on employee well-being, proactive reporting, external collaborations, and adherence to emission reporting policies (Babcock, 2022), position it as a stage 4 sustainable corporation, emphasizing efficiency. This commitment is substantiated by Babcock's recent route-to-net-zero certification, which quantitatively assesses carbon emissions and qualitatively evaluates governance, carbon metrics, implementation, and stakeholder engagement. This certification confirms a 7% absolute reduction in scope 1&2 emissions and business travel-related carbon footprint (Babcock, 2023).

3.3 SWOT ANALYSIS: BABCOCK’S STRATEGIC LANDSCAPE

An analysis of the company’s capabilities in relation to the complex dynamics of its Macro-environment result in the following strengths, weaknesses, opportunities, and threats (a further detailing of which has been left to the appendix):

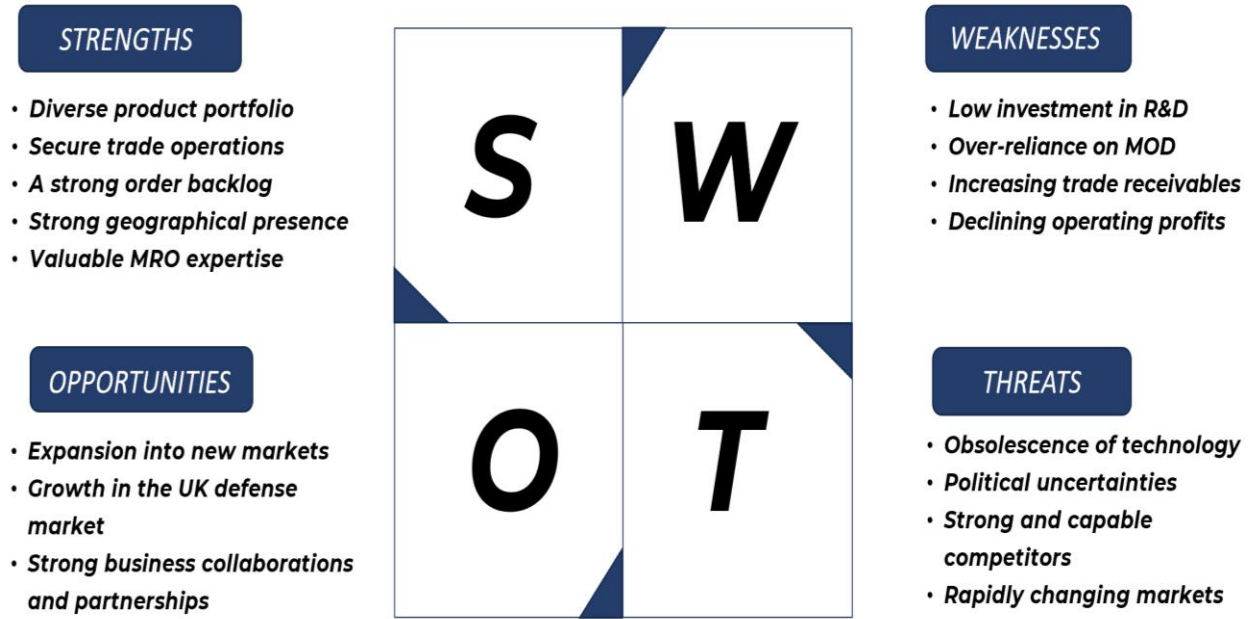


Fig 4: SWOT Analysis of Babcock’s Business

4. STRATEGIC CLIMATE PLANS: INSTITUTIONAL INCENTIVE PERSPECTIVE

Several sustainability initiatives offer opportunities for expanding Babcock's capabilities:

The IMO **Greenhouse Gas Strategy** aims to reduce carbon intensity by 70% along with at least a 50% decrease in total annual GHG emissions from international shipping by 2050 (ICCT, 2018).

The UK Department of Transport's **Clean Maritime Plan** aims to decarbonize domestic shipping by 2050, focusing on alternative fuels and advanced propulsion systems such as electric and hybrid propulsion systems (UK Department of Transport, 2019).

The **Maritime Decarbonization Strategy**, in collaboration with the Department for Transport, aims to implement hybrid powertrain technologies in Royal Navy and Royal Fleet Auxiliary ships by 2030 (Ministry of Defence, 2022).

The Strategic Command's **Sustainable Delivery of Platform Availability** initiative encourages the adoption of innovative technologies for emissions reduction and sustainability integration throughout platform design, procurement, and support activities (MoD Strategic Command, 2022).

Lastly, the Ministry of Defence's **Procurement and Industry Action Plan** aligns with the MoD Climate Strategy by integrating sustainability and emissions considerations into procurement and acquisition while incorporating circular economy principles into designs by 2025 (Ministry of Defence, 2023).

5. RECOMMENDATION

5.1 BABCOCK 4.0

5.1.1 INDUSTRY 4.0 IN DEFENCE

By embracing Industry 4.0, the global A&D Industry can unlock \$20 billion in annual EBITDA (Doucette et al., 2021). PwC's 2022 report on emerging technology trends highlights Artificial Intelligence, Augmented Reality, blockchain, IoT, and additive manufacturing (3D printing) as part of the transformative Essential Eight technologies.

5.1.2 INDUSTRY 4.0 APPLICATIONS AND SUCCESS STORIES

Industry 4.0 technologies have attained maturity in defense and other sectors (Bibby and Dehe, 2018). Companies embracing blockchain see revenue milestones, with 39% generating over \$100 million and 46% exceeding \$1 billion (FinancesOnline, 2023). Additive Manufacturing is booming, with the market projected to reach \$45 billion by 2026, and a 21% rise in global 3D printer shipments by 2027. Meanwhile, IoT foresees an 11% global installed base increase by 2030, and AI revenue will compound at 41% from 2020 to 2025.

Notable defence applications include Lockheed Martin's "Digital Tapestry" for data-driven innovation, Thales' "digital factory" for AI and IoT-driven products, and Boeing's utilization of blockchain for supply chain management and UAVs with SparkCognition (Henderson, J., 2020; Daley, S., 2023; LedgerInsights, 2020; Lopez, C., 2021).

5.1.3 INDUSTRY 4.0'S SUSTAINABILITY IMPACT IN DEFENCE:

Aerospace and Defense Challenge	What Makes Blockchain an Option
Location and Availability of Parts	A <i>decentralized</i> and <i>cost-effective</i> registry of part-inventory locations based on information in existing, distributed systems and locations.
Authenticity of Parts and Supply	A tamper-evident, <i>auditable</i> , and <i>secure</i> record of a part or supplier through its history in the market, including an understanding of export controls (ITAR/EAR) and characteristics like dual use technology.
"As-Operated" Configuration of Assets	A mechanism for collecting configuration inputs from <i>decentralized</i> parties in a highly secure fashion.
Speed of Contract Execution and Payments	An <i>automated</i> set of digital contracts to trigger and execute transfer of value for performance or outcome-based contracts, particularly in the aftermarket.
Lease Return to Service	An <i>auditable</i> , real-time record of the asset coming off lease and its associated documentation. This would compress the time required to return an asset off lease.
Certification of Maintenance and Quality	A mechanism for collecting certification data from <i>decentralized</i> parties in a highly <i>auditable</i> and secure fashion.

Fig 5: and How Blockchain Could Help, Aerospace Industries Association (2019)

Babcock can pioneer a technology ecosystem via an expanded blockchain-connected 3D printing network, enabling localized manufacturing. This introduces a "shared factory" concept, monetizing unused printing capacity, enhancing capacity trading, and utilization potential (Kurpuweit et al., 2020; Klockner et al., 2020).

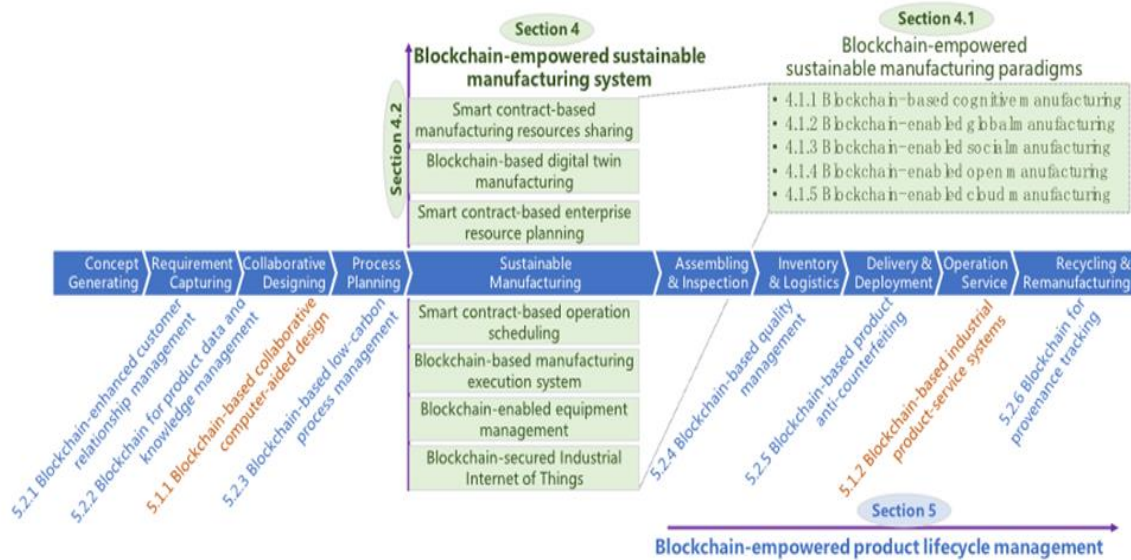


Fig 6: blockchain-empowered sustainable manufacturing outlines, Leng et al (2020)

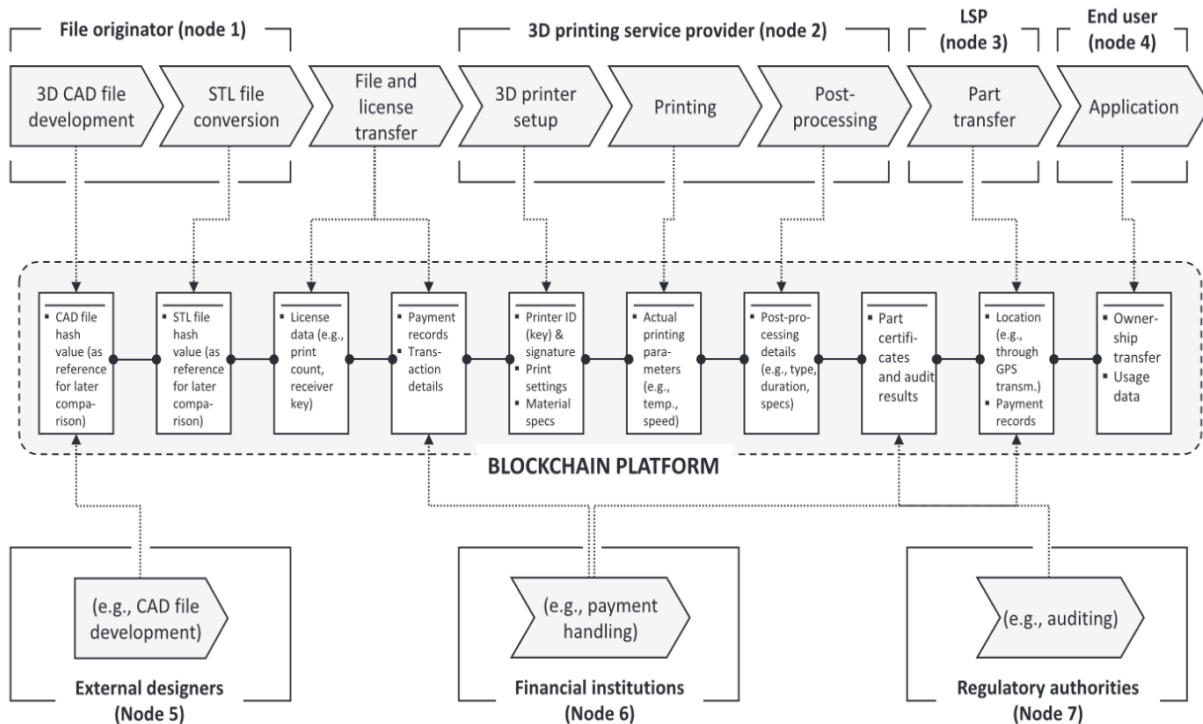


Fig 7: Blockchain Printing for a 3D printing Value Chain, Klockner et al (2020).

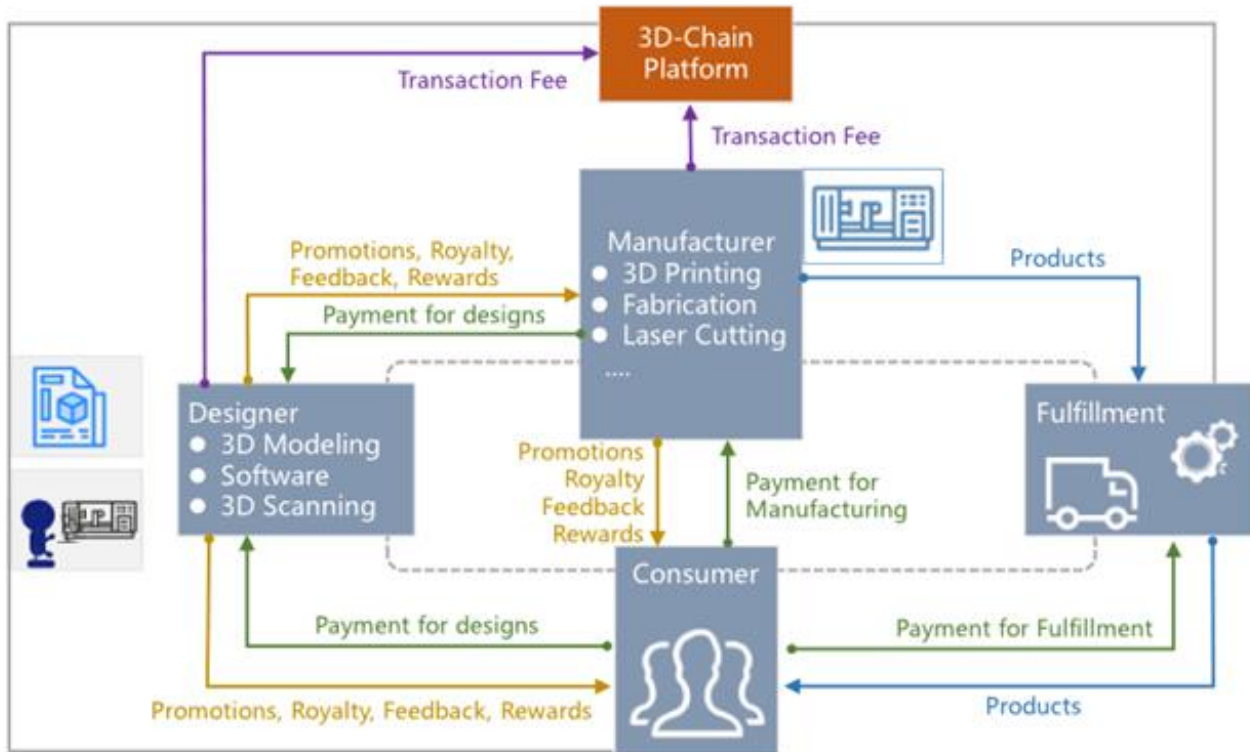


Fig 8: Workflow of a Blockchain based manufacturing, Leng et al (2020).

Augmented Reality finds application in training and Remote Maintenance Operations, with IoT enhancing communication. A MRO 4.0 enables Babcock's integrated virtual system for predictive maintenance, technician support, and logistics (Davies, 2021). Notably, research emphasizes the impact of tech like blockchain, AI, big data, and IoT generating profound sustainability effects (Bai et al., 2020)

The sustainability degree of each I 4.0 across the Automotive, Electronics, Food & Beverage and Textile, Apparel and Footwear Industries

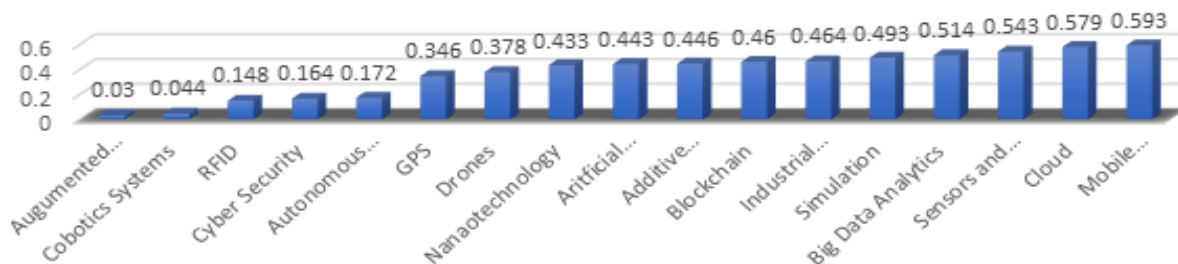


Fig 9: Sustainability Impact of 4.0 Technologies, Bai et al (2020).

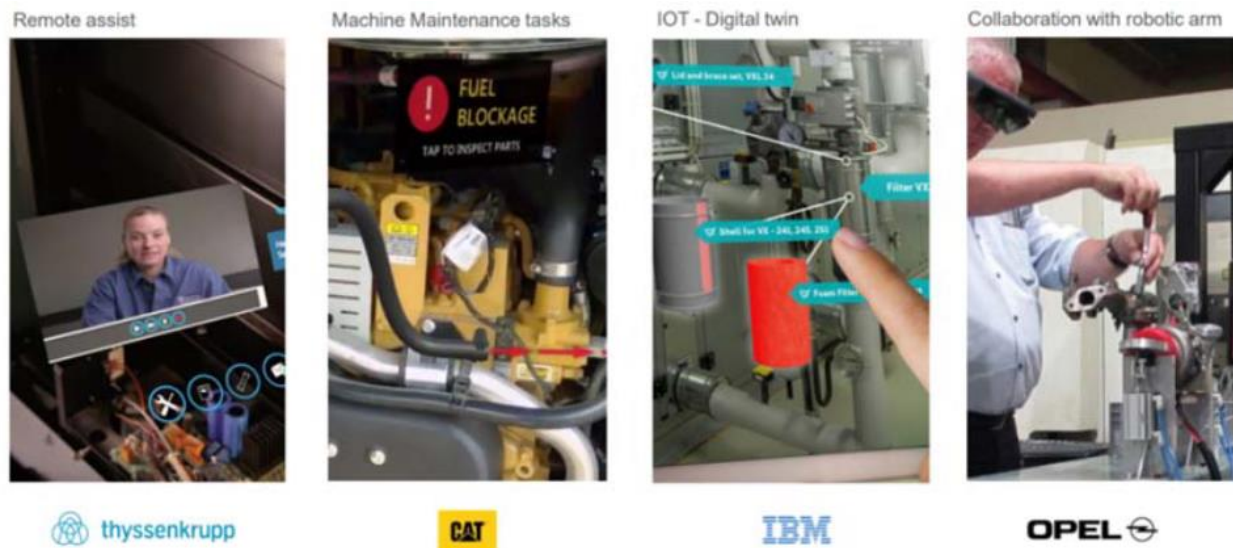


Fig 10: Integration of digital reality in manufacturing, Tabakovic and Durakovic (2020).

5.1.4 LEVERAGING 4.0 FOR UAV MAINTENANCE OPPORTUNITY:

Babcock can leverage these techs for UAV maintenance. Babcock's expansion to UAV maintenance falls in the upper right quadrant of the Ansoff matrix—introducing new services (UAV maintenance) to existing markets (Aerospace and Defence), leveraging existing market knowledge, customer relationships, and channels for innovative product enhancements (Ansoff, 1957).

5.2 BIO LNG: RETROFITTING PERSPECTIVE

5.2.1 CURRENT STATE OF THE MARITIME AND ITS ENVIRONMENTAL IMPACT

The global shipping industry, pivotal for transporting 90% of global goods, also has significant environmental implications (ICS Shipping, n.d.). It also accounts for 2-3% of worldwide CO2 emissions, a figure that may rise to 17% by 2050 if unchecked (Northam, 2021; Whieldon, n.d.). In addressing these emissions, the IMO targets a 50% reduction by 2050, with the IMO 2020

regulation promoting low-sulphur fuels (Stone, 2021; Sinay, 2022). Beyond emissions, the industry impacts marine ecosystems via ballast water releases and occasional oil spills (Sinay, 2022). Moreover, ship noise disrupts marine life (RMG, n.d.), and waste management remains a pressing concern, with illegal dumping posing ecological (Encyclopedia.pub, 2022). Marine sector accounts for 36% of Babcock’s total revenue (International, 2023).

5.2.2 INTRODUCTION TO BIO-LNG AS A SUSTAINABLE ALTERNATIVE FUEL

Bio-LNG, which is derived from organic waste through liquefaction, is becoming a game-changing sustainable fuel in the shipping sector (Nordsol, n.d.; NES Fircroft, n.d.). This renewable gas reduces CO2 emissions by up to 80% compared to traditional marine fuels and holds promise as carbon regulations become stricter (AJOT, 2022; SEA-LNG, 2022). The maritime industry's strong commitment to bio-LNG is evident in their robust decarbonization efforts, ship retrofitting potential, and fuel flexibility strategy, which avoids technological redundancy and pushes them closer to a carbon-neutral future (Global Maritime Forum, 2021).

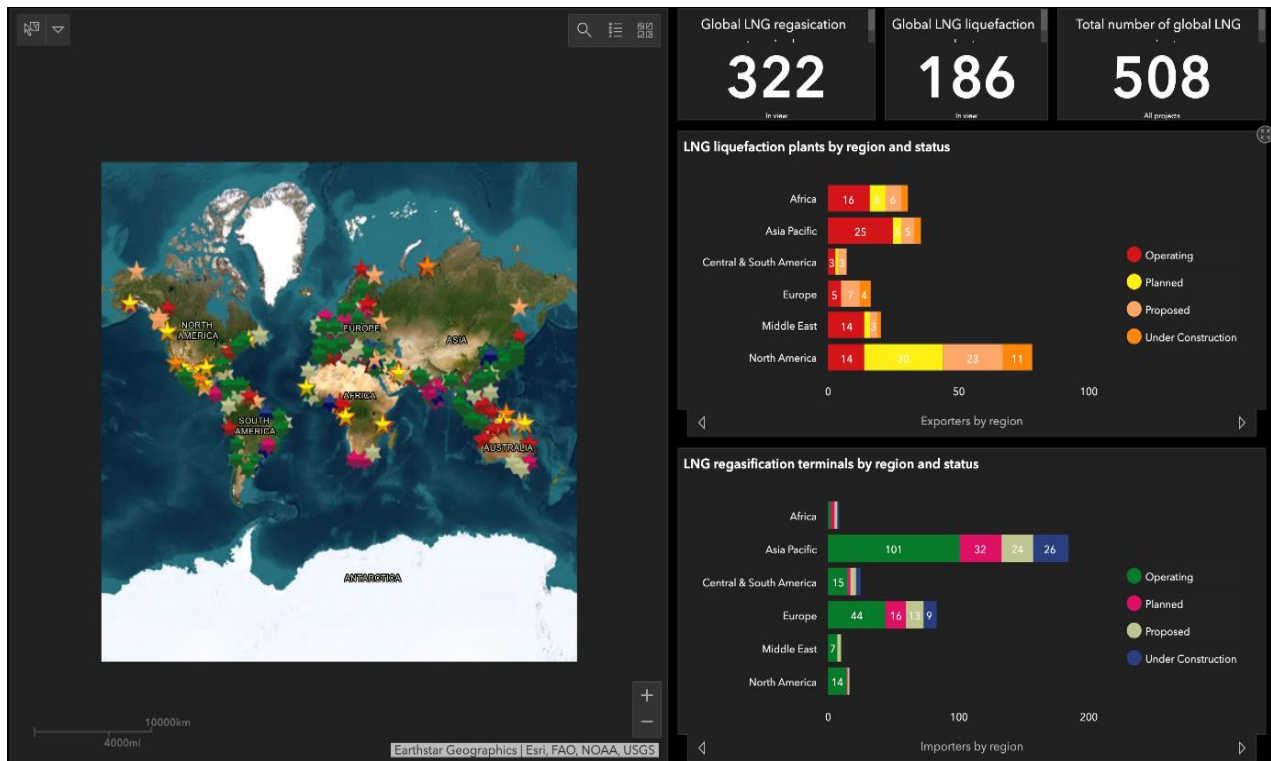


Fig 11: LNG Penetration and Application by Region

5.2.3 MARKET TRENDS AND ADOPTION OF BIO-LNG

The sustainable marine fuel market is expanding notably, driven by increased demand for biofuels and LNG in pursuit of decarbonization by 2050 (Transparency Market Research, n.d.). The industry's shift towards LNG retrofits and exploration of green alternatives like biofuels, hydrogen reflects a push for eco-friendly practices (Hellenic Shipping News, 2020.; ScienceDirect, 2022.). CMA CGM partnered with Shell for a Bio-LNG bunkering trial in Rotterdam, showcasing Bio-LNG's role in a sustainable marine supply chain (S&P Global, 2021).

5.2.4 RECOMMENDATIONS

To steer Babcock International towards its 2040 Net Zero aim, we recommend:

1. Retrofit Bio-LNG for MOD Fleet:

- Evaluate retrofit feasibility based on vessel age, engine compatibility, and consumption.
- Collaborate with tech providers for retrofit designs, utilizing existing UK LNG bunkering facilities for bio-LNG supply.

2. Enhance MRO Services for Green Fuel Vessels:

- Expand service offerings for diverse green fuels such as hydrogen and battery-powered vessels.
- Foster OEM partnerships for insights on alternative fuel engines and technologies.

3. Sustainable Ship Recycling:

- Collaborate with responsible ship recycling yards via due diligence.
- Investigate component reuse via proper dismantling and treatment.

5.3 HYBRID ELECTRIC PROPULSION

5.3.1 SUSTAINABILITY LANDSCAPE IN MARINE AND AVIATION INDUSTRIES:

The maritime industry, characterized by low profit margins, long asset life cycles, and complex incentive structures, traditionally hesitates to embrace new technologies (*Maritime 2050: navigating the future*, 2019) while the aviation industry, despite rapid growth, grapples with rising greenhouse gas emissions. To meet 2050 environmental goals, aviation must rethink its propulsion technologies with objectives including sustainable growth (Rendón *et al.*, 2021).

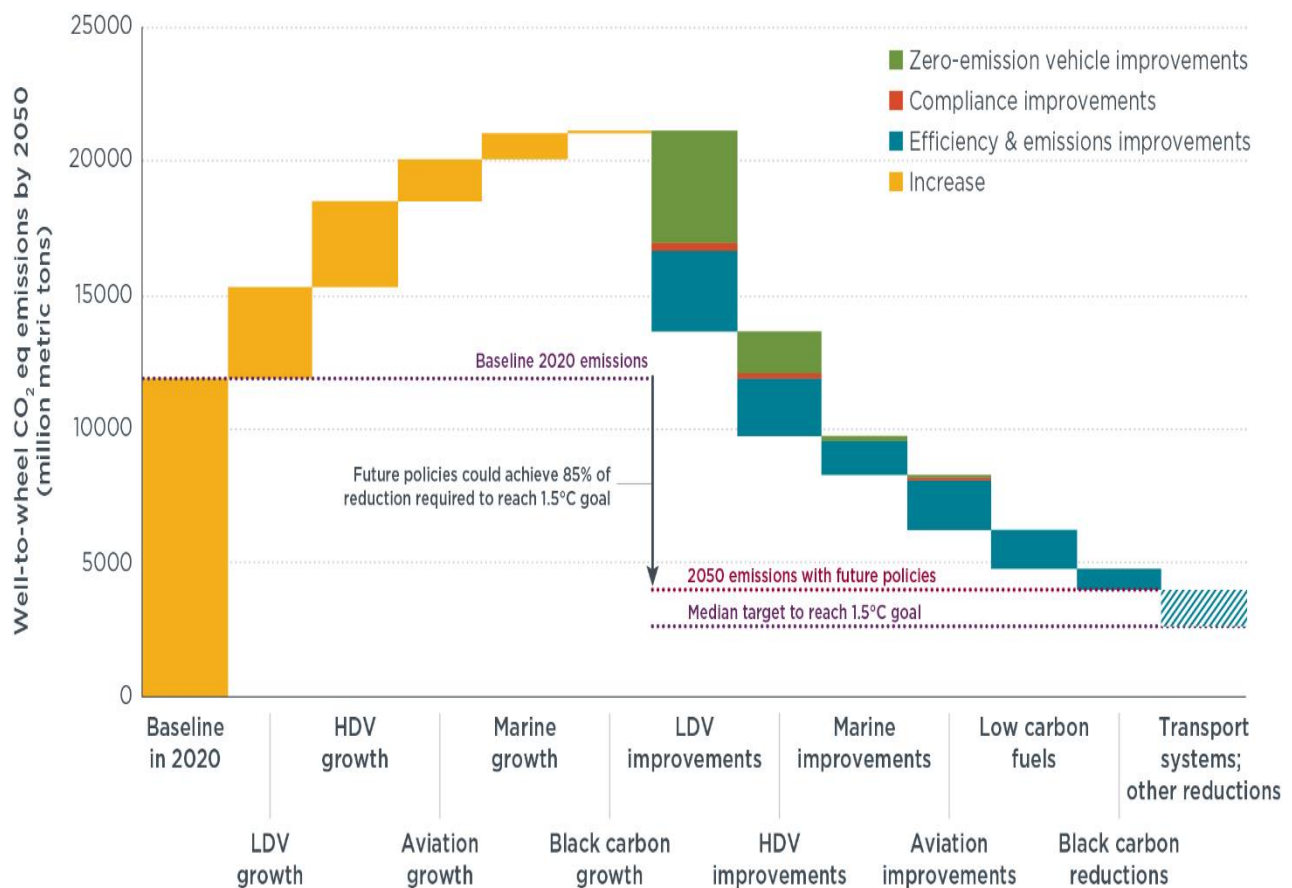


Fig 12: emissions and mitigation potential in 2050 by transportation (Kodjak, 2021).

5.3.2 MARKET GROWTH AND COMPETITIVE LANDSCAPE:

Industry leaders like Airbus, Siemens, Rolls-Royce, and Boeing are heavily investing in HEP for shorter-range aircraft, with the market expected to reach USD 30 billion by 2030 (*Global Hybrid Electric Aircraft market size*, n.d). The maritime sector is also embracing hybrid propulsion systems, poised to grow upto USD 6.213 billion by 2032. Collaborations, such as Danfoss Editron's

hybrid-electric vessel and ABB's emission-free ferry tech, signify industry momentum (*Marine Hybrid Propulsion System market size*, n.d).

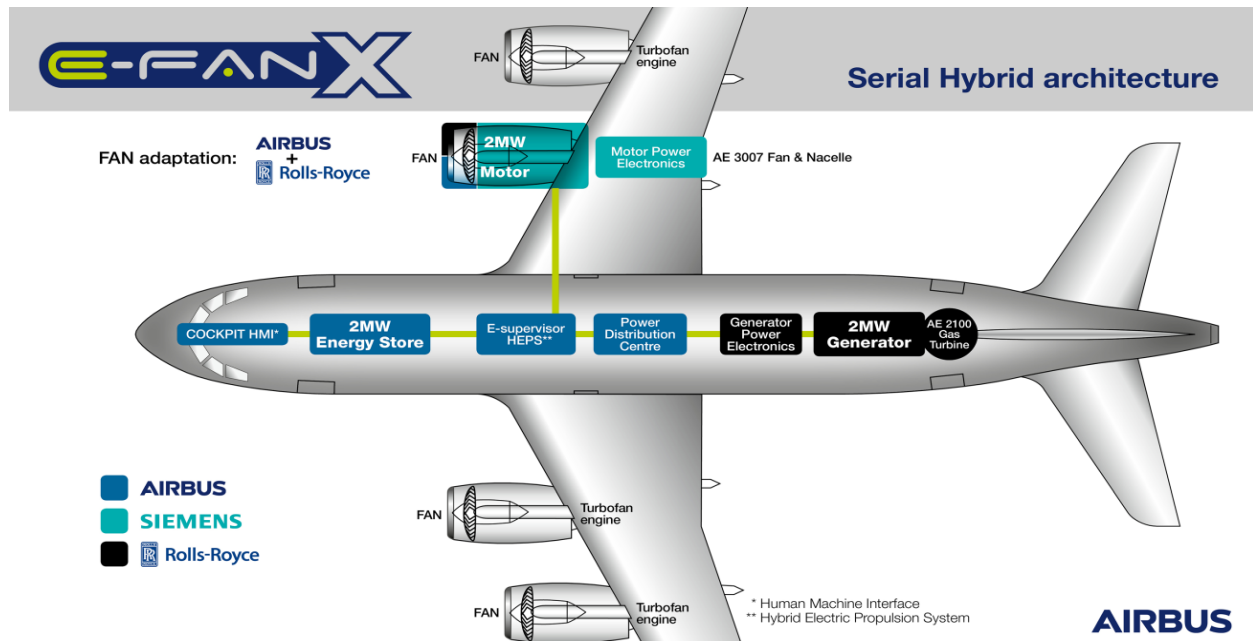


Fig 13: Rolls-Royce, Airbus and Siemens partner to deliver hybrid electric jets (n.d)

5.3.3 ADVANTAGES FOR BABCOCK

The adoption of HEP presents Babcock with strategic advantages that extend beyond efficiency.

Market Leadership: embracing HEP enhances Babcock reputation and market positioning.

Government Support: Babcock may leverage government incentives for HEP projects, enhancing its financial viability.

Futureproofing: As the industry shifts toward sustainable practices, Babcock's early adoption of HEP ensures its readiness for evolving market demands.

Diversification: HEP enables Babcock to diversify its product and service offerings, tapping into emerging markets and growth opportunities.

5.3.4 RECOMMENDATIONS

1. **Research and Development:** Initiate a focused R&D program HEP technology.
2. **Government Engagement:** Collaborate with government initiatives to access funding and support for HEP technology adoption.

5.4 WASTE HEAT RECOVERY

5.4.1 OVERVIEW OF THE WHR TECHNOLOGY

WHR technology capitalizes on capturing and transferring thermal energy from gas or liquid processes to create additional energy resources. This energy can be harnessed for supplementary heat, electrical power, or mechanical power.

5.4.2 ENVIRONMENTAL BENEFITS:

Approximately 31% of the UK's industrial thermal processes demand involves low-temperature process heat, with a notable 20% offering significant potential for industrial WHR (Jouhara, H. et al., 2018). As Babcock plays a pivotal role in Type31 production, which supports industries like iron, steel, and refineries, adopting WHR brings substantial benefits. Industry benchmarks highlight heat recovery systems typically achieve efficiency levels ranging from 50% to 80%, further emphasizing the potential enhancement for Babcock's Type31 production efficiency (The Renewable Energy Hub, 2023).

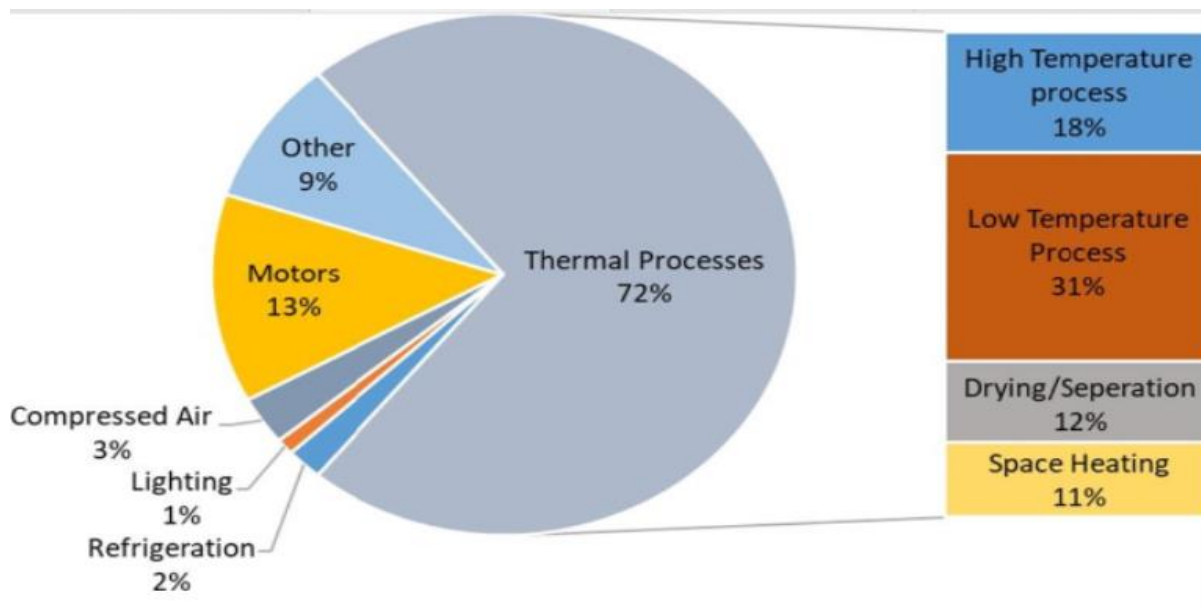


Fig 14: Energy consumption in the UK manufacturing industry

5.4.3 MARKET GROWTH AND OPERATIONAL SUCCESS

The WHR market is set to reach \$114.7 billion by 2028 with a CAGR of 9.2%, driven by successes like the ORC in marine applications, showcasing its feasibility and potential for fuel savings (M, H., 2022). Six reported instances of ORC use on ships highlight its promise, especially for smaller vessels. For instance, an LNG-fuelled platform supply vessel achieved up to 7% fuel savings with a three-year investment payback period (Ng, C., 2019). This makes a compelling financial case for WHR adoption within Babcock's energy management strategy and broader sustainability objectives.





				
Vessel Name	MV Figaro (2012)	Viking Grace (2015)	Arnold Maersk (2016)	Asahi Maru (2017)
ORC Maker	Opcon	Climeon	Calnetix	Kobe Steel
Capacity (kW)	500kW	150kW	125kW	125kW
Heat source	Genset cooling water	Genset cooling water & exhaust	Engine cooling water	Engine exhaust
Fuel savings	4-6% up to 5-10%	Up to 5%	Up to 10-15%	3%
Classification	Lloyd's Register	Lloyd's Register	ClassNK and Lloyd's Register	ClassNK

Fig 15: Real world Marine WHRS Applications, Ng, C. (2019)

5.4.4 BENCHMARKING COMPANIES

Company	Based country	Year Found	Description
<u>Orcan Energy</u>	German	2008	Uses <u>Organix</u> Ranking Cycle (ORC) technology to turn low-temperature waste heat into clean electricity. Sold more than 500 modules globally.
<u>FutraHeat</u>	England	2021	Uses high-temperature heat pumps called <u>TurboClaw</u> to turn waste heat into steam. It has joined force with Honeywell
Water Horizons	France	2017	Uses a thermochemical process to recover and store waste heat into mobile thermal battery.

Tab 2: Companies and What They Do with Waste Heat

These companies have leveraged innovative approaches to convert waste heat into clean electricity and steam, offering valuable insights for Babcock's potential implementation.

5.4.5 RECOMMENDATIONS

1. **Facility heating optimization:** Implement WHR for addressing water heating requirements and supporting space heating in buildings and industrial facilities.
2. **Marine application enhancement:** Incorporate WHR in type 31 vessels to improve energy efficiency during marine operations.

5.5 SOCIAL IMPACT: SERVING VETERANS

5.5.1 OVERVIEW OF VETERANS

Veterans are those who have participated in legally recognised military activities for at least one day while serving in Her Majesty's Armed Forces (*Office, 2020.*) As heroes who have answered the call of duty, veterans carry a wealth of invaluable attributes that remain largely untapped resources, waiting to be unlocked for the betterment of both their own lives and the nation they have faithfully served.



Fig 16: The Princess Royal meets veterans at the Not Forgotten Association Garden 83, The Independent, 2022)

5.5.2 DEMOGRAPHIC INSIGHTS:

In 2021, over 1.85 million persons in England and Wales identified as veterans, comprising 3.8% of residents aged 16 and above (Office for National Statistics, 2021.). Of the veteran population, 40% fall within the 16-64 age range, while 60% are aged 65 and above (Support for UK Veterans, 2020.). Despite preconceptions, veterans come from diverse backgrounds, reflecting the multifaceted nature of military service (Tapping into - Raconteur, 2023.).

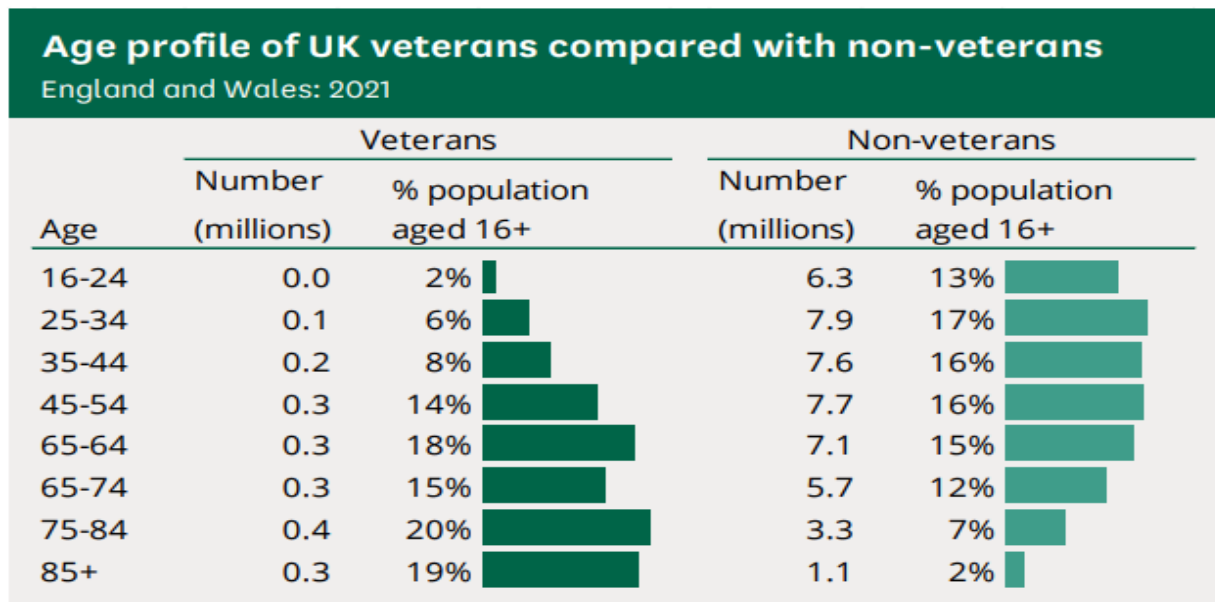


Fig 17: support for veterans(Office,2020.)

5.5.3 TRANSITIONAL CHALLENGES AND OPPORTUNITIES:

Transitioning from military to civilian life can be challenging for veterans, with varying degrees of difficulty. While some seamlessly integrate into new careers, others require support to navigate this transition. (New Research Reveals Armed Forces Veterans, 2019.). Contrary to stereotypes, military experience does not equate to violence; instead, veterans possess a wide range of talents gained during their military service. From leadership and teamwork to adaptability and problem-solving, their skills are transferable and beneficial to various industries.

5.5.4 RECOMMENDATIONS

1. Reservist Recruitment and Skill Utilization:

By recruiting veterans as reservists, Babcock can tap into their extensive experience training military personnel for critical missions. This strategy capitalizes on their skills and enhances Babcock's capabilities.

2. Community Empowerment and Civic Engagement:

Utilizing our partnerships with metro police and fire rescue teams, Babcock can deploy veterans to educate civilians in self-defense and execute prompt fire alarm rescue operations, ultimately reducing response times.

3. Collaborations with NGOs:

Strategic alliances with veteran support NGOs foster integration, guidance, and a nurturing environment, ensuring veterans thrive in their post-service lives.

6. ENVISIONING THE ECOSYSTEM

6.1 THE DIGITAL MANUFACTURING AND MAINTENANCE HUB

Create a center for digital manufacturing and maintenance for Utilizing these technologies to streamline the production and maintenance of defense equipment, outsourcing unutilized manufacturing capacity where possible. This hub will serve as the starting point for supplementary projects.

6.2 MAKING ASSETS INTELLIGENT

- **Sustainable Vessel Retrofitting and Advanced MRO:** Expand the hub's ability to upgrade existing vessels with Bio LNG technology, Sustainable Vessel Retrofitting and provide Advanced MRO services for Bio LNG boats.
- **Hybrid-Electric Research and Implementation:** Utilize the digital infrastructure of the hub to perform research on hybrid-electric engines for use in aviation and the maritime sector, with integrated data streams of hybrid engines feeding back into the core technology hub.
- **WHR Integration:** Implement WHR systems in the current ship engines and industrial facilities, making use of data analytics to improve WHR procedures.

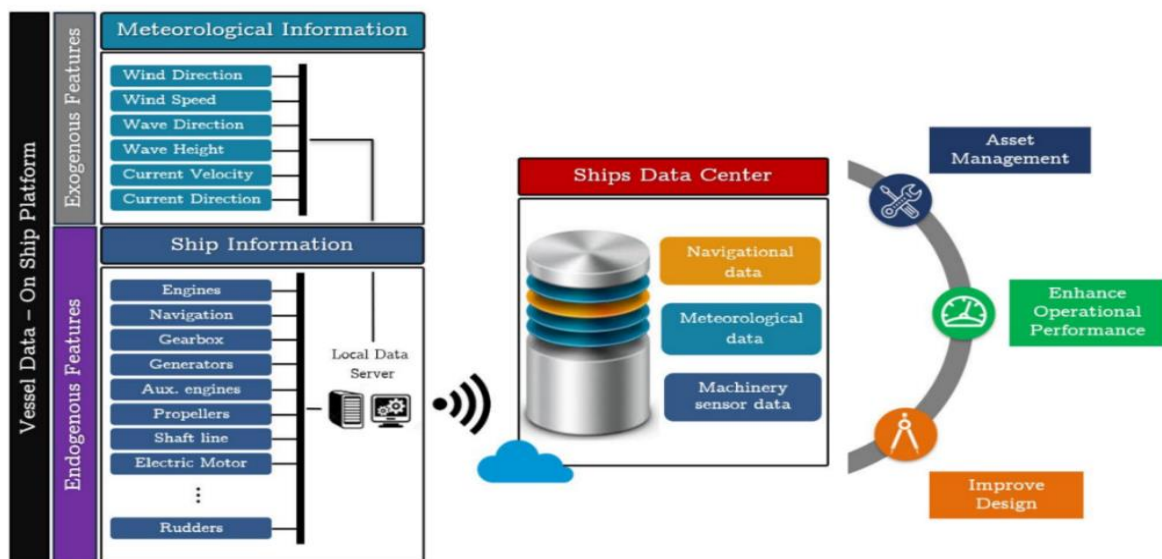


Fig 18: The “Datafication” process of a vessel as presented by Coraddu et al (2022).

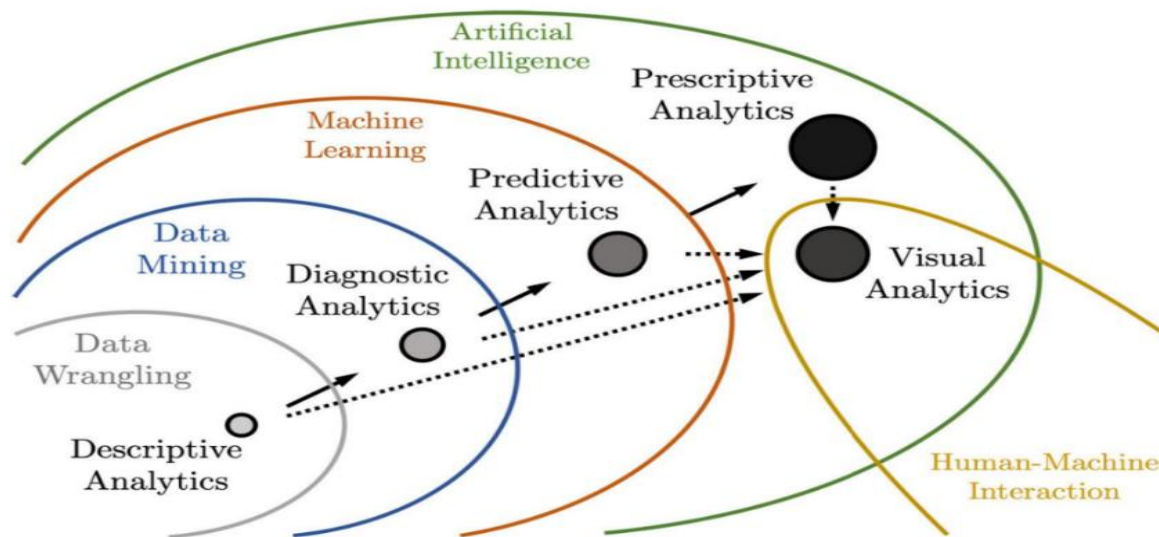


Fig 19: Analytics approaches for shipping energy systems, Coraddu et al (2022).

6.3 LEVERAGING NEW TECHNOLOGIES TO CREATE NEW CUSTOMER OFFERINGS

UAV Maintenance and Beyond:

Expand the capacity of the digital hub to provide UAV repair services utilizing Industry 4.0 technology and facilitate cross-learning across various defence asset maintenance fields.

7. THE ADKAR FRAMEWORK: ENSURING SUSTAINABLE CHANGE

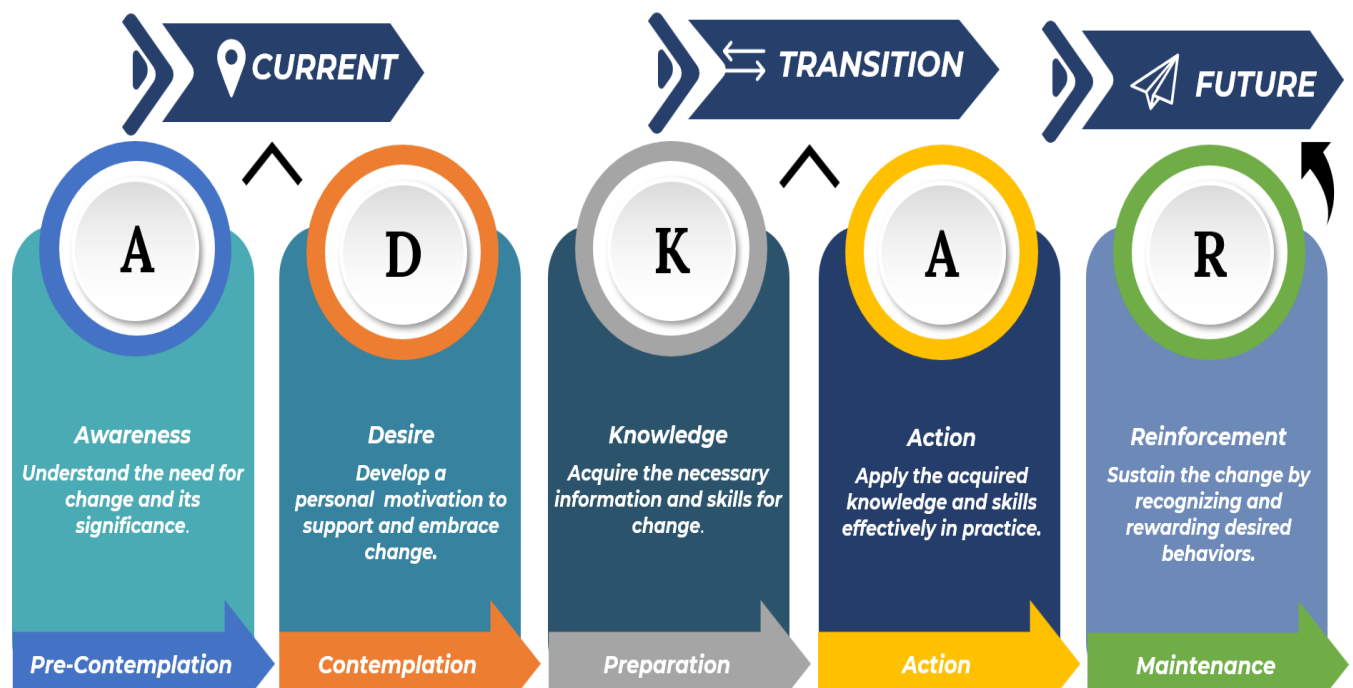


Fig 20: ADKAR MODEL

The ADKAR model is a structured framework that can facilitate both organizational and individual change at Babcock. It begins with "unfreezing" current mindsets, creating awareness and a desire for change, then equips individuals with the needed knowledge and skills for the transition. Finally, it "refreezes" these changes through ongoing reinforcement. This model emphasizes behavioural aspects crucial for successful adoption, aiding Babcock's change managers in addressing potential challenges effectively (Stöckert, 2021).

8. IMPLEMENTATION TIMELINE: STRATEGIC TECHNOLOGICAL PHASES

Considering the high average timeline of defence organization, we have categorized our recommendation in Now, Near and Far. We categorized these recommendations based on availability of technology and ease of implementation.

	Babcock 4.0	Alternative fuels	Hybrid Electric Propulsion	Waste Heat Recovery	Veterans Initiatives
NOW 4 – 5 Years	<ul style="list-style-type: none"> • Map out your Industry 4.0 Strategy • Create initial pilot projects • Define the capabilities you need 	<ul style="list-style-type: none"> • Retrofitting existing ships to BIO-LNG with partnership 	<ul style="list-style-type: none"> • Feasibility study for electric propulsion. • Develop prototype systems. 	<ul style="list-style-type: none"> • Technology development • Use in asset management 	<ul style="list-style-type: none"> • Collaborating with the NGO'S. • Conducting necessary Surveys.
NEAR 6 – 10 Years	<ul style="list-style-type: none"> • Implement strategy • Make assets intelligent • Create new services/platform 	<ul style="list-style-type: none"> • Adapt to market requirements • Possibility of safe hydrogen & ammonia fuels 	<ul style="list-style-type: none"> • Complete first-gen propulsion development. • Initiate pilot projects on vessels. 	<ul style="list-style-type: none"> • Infrastructure development • Apply in industrial plants 	<ul style="list-style-type: none"> • Conducting Trainings. • Involving Civilians in Basic Trainings.
Far 11 + Years	<ul style="list-style-type: none"> • Actively implement an ecosystem approach 	<ul style="list-style-type: none"> • Battery electric propulsion system advancement • 100% drop-in synthetic fuel 	<ul style="list-style-type: none"> • Scale up system production. • Expand pilot projects fleet-wide. 	<ul style="list-style-type: none"> • Ready for commercial use • Open for use in contracts 	<ul style="list-style-type: none"> • Collaborations with Educational Institutions.

Tab 3: Implementation Timeline

9. RISK, LIMITATIONS & UNCERTAINTY

- **Cost, Budget, and Infrastructure Constraint:**

Bio-LNG and WHR present challenges due to production limitations, infrastructure costs, and high initial investments (Nordsol, 2023; de Rubeis et al., 2022). HEP needs infrastructure upgrades, possibly clashing with legacy systems. Government incentives and tech advances offer opportunities but require meticulous budgeting (Damian et al., 2022).

- **Cybersecurity Vulnerabilities:**

The adoption of Industry 4.0 technologies in defence introduces cybersecurity vulnerabilities, potentially resulting in data breaches, system disruptions, and unauthorized access (Avdibasic, 2022).

- **Technological Complexity, Immaturity, And Safety:**

Some technologies lack maturity and may pose safety concerns, making their integration complex. (Geniusee, 2023) Regulatory hurdles can slow progress, Careful planning and risk management are crucial for success. (Deloitte Insights, 2019)

10. POTENTIAL AREAS WORTH LOOKING INTO

- **Rail emissions free maintenance**

The prospect of emissions-free rail maintenance presents a significant opportunity for Babcock in the realm of railway and track maintenance sector, by integrating battery, electric, and hybrid-powered equipment, Babcock can enhance its services sustainably. Collaborating with companies pioneering emission-free solutions offers a strategic opportunity to lead in eco-friendly rail maintenance.

- **Advanced materials**

Advanced materials boost aircraft agility, hypersonic systems' effectiveness, protective gear, and risk mitigation. Recent advancements, like self-healing carbon Fiber-reinforced polymers, bolster aircraft design while their strength and lightness can revolutionize automotive fuel efficiency (Intelligence, 2021). The breakthroughs in nonlinear metamaterials underscore the potential Babcock should explore, amplifying their competitive edge.

11. CONCLUSION

This report extensively evaluates Babcock's current product and service portfolio in light of emerging trends and societal shifts. It identifies key areas ripe for new market opportunities, growth, and innovation to ensure alignment with dynamic customer needs, enhancing both relevance and resilience.

The project's central focus lies on the recommendations and visualization framework designed for seamless implementation. By integrating Industry 4.0-driven eco-efficiency, WHR systems, hybrid ship electrification, and sustainable fuel MRO services, Babcock positions itself to harness technological advancements while championing environmental responsibility. These actions reaffirm the company's commitment to addressing Climate Change and fostering sustainable development, solidifying its status as an industry leader dedicated to conscientious practices.

Furthermore, the introduction of the "Supporting Veterans" initiative highlights the company's dedication to social impact. By leveraging veteran expertise to serve society, Babcock extends its contributions beyond commerce, reinforcing its commitment to community upliftment.

In essence, this project aligns Babcock with global trends, promoting innovation, sustainability, and social impact. With commitment and strategic vision, Babcock can pioneer a path that capitalizes on opportunities while championing environmental preservation and community well-being.

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APPENDIX

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ABBREVIATIONS

1.	MRO	Maintenance and repair and operation
2.	ACV	Amphibious combat vehicle.
3.	AI-	Artificial Intelligence
4.	ML	Machine Learning
5.	A&D	Aerospace and defence
6.	OEMs	Original equipment manufacturer
7.	MBE	Model based Enterprise
8.	IOT	Internet of things
9.	AAM	Advanced air mobility
10.	eVTOL	Electric Vehicles take-off and landing aircrafts
11.	ESG	Environmental Social and governance
12.	WAR	Warfighter Augmented Reality
13.	UAV	Unmanned aerial vehicle.
14.	MOD	Ministry of Defence
15.	IMO	International Maritime Organization
16.	CMA	Cost and management accounting
17.	CGMA	Chartered Global Management Accountant
18.	ROI	Return on Investment
19.	WHR	Waste heat recovery
20.	ORC	Organic Rankine cycle
21.	RAF	Royal air force
22.	NGO	Non-Government Organization

PROJECT CHARTER

Project Charter	
Project title:	Evaluating the Future of Babcock's Products and Services in Congruence with shifts in societal dynamics and carbon emission regulation
Team & revision date:	Team: Wasim Manihar, Supreet Venkoba Dhayapule, Tanvi Ashutosh Pandit, Kei Ying Cheng, Abrar Imdad Kanekar, Sadiq Tijjani Umar Date: 13-06-2023
Project purpose:	This project aims to evaluate the future of Babcock's products and services in light of technology, consumer behaviour, and market dynamics changes and the company's commitment to reducing carbon emissions and creating social value.
Project objectives:	<ol style="list-style-type: none"> Conduct a comprehensive review of global trends and developments, including changes in technology, consumer behaviour, and market dynamics. Success Criteria: <ol style="list-style-type: none"> Completion of a thorough analysis of key global trends and developments impacting the aerospace and defence industry. Identification of emerging technologies, consumer behaviour shifts, and market dynamics relevant to Babcock's products and services. Documentation of key findings in the comprehensive report. Evaluate the company's current products and services portfolio and identify areas for new markets, potential growth, and innovation considering societal changes, emerging trends, and customer needs. Success Criteria: <ol style="list-style-type: none"> Assessment of Babcock's current products and services portfolio, including analysis of strengths, weaknesses, and alignment with emerging trends and customer needs. Identification of potential new markets and growth opportunities based on the evaluation. Development of recommendations for innovation and diversification of products and services. Presentation of the evaluation findings and recommendations to project sponsors and key stakeholders. Develop recommendations and a framework or visualization for the company to align its products and services offering with areas of growth, societal changes, and the company's commitments to addressing climate change and sustainable development. Success Criteria: <ol style="list-style-type: none"> Formulation of clear and actionable recommendations for Babcock to align its product and service offerings with areas of growth, societal changes, and sustainability. Development of a framework or visualization to aid in strategic decision-making and alignment with the company's commitments to addressing climate change and sustainable development.

<p>3) Alignment of the recommendations and framework with Babcock's strategic goals and objectives.</p> <p>4) Presentation of the recommendations and framework to project sponsors and key stakeholders.</p> <p>4. Deliver a report, including an executive summary, outlining the findings of the analysis, including recommendations for areas of growth and innovation.</p> <p>Success Criteria:</p> <p>1) Completion of a comprehensive report documenting the analysis process, key findings, and recommendations.</p> <p>2) Clarity and coherence in presenting the findings and recommendations.</p> <p>3) Report approval by the project sponsor and Academic Supervisor.</p>
<p>High level project description & key deliverables:</p> <p>Project Description: The project will begin with a comprehensive review of global trends and developments, encompassing technology advancements, shifts in consumer behavior, and evolving market dynamics. This analysis will form the foundation for evaluating Babcock's current products and services portfolio in the sector of marine, land and aviation excluding <i>the nuclear sector</i> by identifying strengths, weaknesses, and alignment with emerging trends and customer needs, the project will uncover areas for potential growth, innovation, and entry into new markets.</p> <p>Based on the evaluation findings, the project will develop strategic recommendations and a framework or visualization for Babcock to align its products and services offering. The recommendations will focus on leveraging emerging opportunities, addressing societal changes, and incorporating sustainable practices to drive growth and market competitiveness. The framework or visualization will aid in strategic decision-making, ensuring alignment with Babcock's commitments to addressing climate change and sustainable development.</p> <p>The project will culminate in the delivery of a comprehensive report, including an executive summary, which will outline the analysis findings, highlight the recommended areas of growth and innovation, and present the framework for aligning Babcock's product and service offerings. The report will be accompanied by a presentation to project sponsors and key stakeholders, providing an opportunity for engagement, feedback, and endorsement of the recommendations.</p> <p>Key Deliverables:</p> <ul style="list-style-type: none"> • Comprehensive report with an executive summary outlining the findings of the analysis and recommendations for areas of growth and innovation. • Recommendations and a framework or visualization for Babcock to align its products and services offering with areas of growth, societal changes, and the company's commitments to addressing Climate Change and sustainable development. • Presentation of findings and recommendations to project sponsors and key stakeholders.
<p>Summary milestone schedule:</p> <ul style="list-style-type: none"> • Project Kick Off – 08/06/2023. • Project Charter Finalisation – 21/06/2023 • Plan phase completion-26/06/2023 • Project research completion-20/07/2023 • Presentation – mid august/2023 • Project report completion- 03/09/2023
<p>Key stakeholders:</p>

<ul style="list-style-type: none"> • Tim Baxter (Project Sponsor) - Babcock International Group, Capability Road mapping Manager • Brian Rutter (Academic Supervisor) • Steve Cayzer (Academic Assessor) • Project Team Members
Key assumptions:
<ul style="list-style-type: none"> • The availability of necessary data and information required for conducting the review and evaluation. • Access to relevant stakeholders and subject matter experts for gathering insights and inputs. • Compliance with legal, regulatory, and ethical considerations during the evaluation process.
Key project risks:
<ul style="list-style-type: none"> • Inaccessible or outdated data and information sources. • Changing market dynamics and emerging trends may render some findings or recommendations obsolete. • Regulatory changes impacting strategic direction. • Technological changes outpacing the project timeline.
Project sponsor & assigned project manager:
<p>Project sponsor: Tim Baxter</p> <p>Project manager: Wasim Manihar</p> <p>Project Point of Contact: Supreet Venkoba Dhayapule</p> <p>Project Ethics Lead: Tanvi Ashutosh Pandit</p>

TEAM CHARTER

Mission: Evaluate the Future of Babcock production services in the context of societal changes and company commitment to sustainability	<p>Roles:</p> <p>Wasim Manihar (Project manager)</p> <p>Supreet Dhayapule (Point of Contact)</p> <p>Tanvi Ashutosh Pandit (Ethics Lead)</p> <p>Kei Ying Cheng (Notes Master)</p> <p>Abrar Imdad Kanekar (Question Curator)</p> <p>Sadiq Tijjani Umar</p>	<p>Strengths:</p> <p><u>Wasim Manihar</u>: leadership, Project management, Creative thinking.</p> <p><u>Abrar Imdad Kanekar</u>: Research</p> <p><u>Tanvi Ashutosh Pandit</u>: Problem solving, communication, research.</p> <p><u>Kei Ying Cheng</u>: Financial analysis, Supply chain expertise, time management.</p> <p><u>Supreet Dhayapule</u>: Presentation skills, communication, technical skills, stakeholder management.</p> <p><u>Sadiq Tijjani Umar</u>: Research and data analysis, report writing, good with numbers, presentations.</p>
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<p>Scope:</p> <ul style="list-style-type: none"> -Limited access to some company information. -Conducting research and analysis to develop strategic plans and recommendations. -Evaluating current Babcock product portfolio -Assessing potential risks, vulnerabilities and threats faced by Babcock. -Establishing project plans, defining milestones, allocating resources, monitoring progress and ensuring timely delivery of project outcomes. 	<p>Fun Events:</p> <p>Socials and get-togethers.</p>	<p>Weaknesses:</p> <ul style="list-style-type: none"> -All team members have a similar Myers Briggs profile. -No real-world working experience.
<p>Values:</p> <ul style="list-style-type: none"> -Creating an environment that encourages belonging and togetherness and fosters teamwork. -Bridge similarities to appreciate differences. -Treating one another with kindness and empathy. 	<p>Goals:</p> <p><u>Product Oriented:</u></p> <ul style="list-style-type: none"> -Curate a report outlining research findings including recommendations for areas of growth and innovation. -Curate a framework for Babcock to align its product/services in relation to external changes. <p><u>Process Oriented:</u></p> <ul style="list-style-type: none"> -Consistent Communication attitudes during project. -Feedback and improvement cycles after meetings. <p><u>Measurement Criteria:</u></p> <ul style="list-style-type: none"> -Feedback from project and academic supervisors. -Benchmark previous projects. 	<p>Norms:</p> <ul style="list-style-type: none"> -Creating a safe space for sharing Ideas. -Collaborating on work delivery processes. -Collective conflict management approach. -Weekly feedback sessions. -Equal Distribution of workload. - Regular meetings per week. -Vote based decision making processes. -Punctual attitudes towards meetings and project deadlines. -Learn one new concept per week, meet someone new every week and do an act of kindness every week.

ROAD MAP

Practise track Project	Project Start	05/06/2023	project end date	03/09/2023		
	total number of Weeks	12				
Team Ace						
Task	responsible	progress	estimated start	estimated end	actual start	actual end
INITIATING PHASE	ALL	100%	5 Jun	16 Jun	5 Jun	16 Jun
Understanding the Project Brief	ALL	100%	5 Jun	16 Jun	5 Jun	16 Jun
Create Team Bios	ALL	100%	5 Jun	8 Jun	5 Jun	8 Jun
Prepare Questions for Kick Off Event	ALL	100%	6 Jun	8 Jun	6 Jun	8 Jun
Assign Roles and Main Responsibilities	ALL	100%	8 Jun	8 Jun	8 Jun	8 Jun
Define Communication Channel	ALL	100%	8 Jun	8 Jun	8 Jun	8 Jun
PLANNING PHASE		86%				
Create Team Charter	ALL	100%	8 Jun	22 Jun	8 Jun	15 Jun
Clarify Scope with the Client	ALL	80%	8 Jun	30 Jun	8 Jun	27 Jun
Create Project Charter	ALL	100%	8 Jun	16 Jun	8 Jun	23 Jun
Create Business Report with Document Template	WASIM	50%	22 Jun	30 Jun	22 Jun	28 Jun
Create Project Plan	ALL	100%	16 Jun	26 Jun	16 Jun	26 Jun
RESEARCH PHASE	ALL	19%	22 Jun	12 Jul	26 Jun	15 Jul
Understanding Global Trends and Developments, Benchmarking: Land	CHRISTY, SUPREET	25%	22 Jun	9 Jul	26 Jun	5 Jul
Understanding Global Trends and Developments, Benchmarking: Marine	TANVI, WASIM	25%	22 Jun	9 Jul	26 Jun	5 Jul
Understanding Global Trends and Developments, Benchmarking: Aviation	ABRAR, SADIQ	25%	22 Jun	9 Jul	26 Jun	6 Jul
Research Technological Advancements in A&D Industry	ALL	25%	26 Jun	9 Jul	26 Jun	8 Jul
Analyse Changing Consumer Behaviours & Identify Driving Factors	ALL	20%	29 Jun	9 Jul	26 Jun	10 Jul
Identify New Market Dynamics	ALL	10%	22 Jun	9 Jul	26 Jun	10 Jul
Study the Environmental, Social and Governance (ESG) Trends	ALL	0%	22 Jun	12 Jul	26 Jun	10 Jul
EVALUATION PHASE			9 Jul	31 Jul	9 Jul	26 Jul
Analyse Babcock's Current Products and Services	ALL	15%	9 Jul	31 Jul	9 Jul	20 Jul
Evaluate Their Alignment in Recent Trends, Consumer Behaviour and Market Dynamics	SADIQ	25%	9 Jul	31 Jul	9 Jul	21 Jul

Identify Products and Services in Portfolio that can be Leveraged or Adapted to Meet the Needs	WASIM, SUPREET	30%	9 Jul	31 Jul	9 Jul	21 Jul
Assess this Needs in Reducing Carbon Emissions and Creating Social Value	ABRAR, TANVI	80%	9 Jul	31 Jul	9 Jul	20 Jul
Identify Gaps or Opportunities for Improvement in the Market Needs	CHRISTY	90%	9 Jul	31 Jul	9 Jul	28 Jul
Meeting with Clients on Progress	ALL	100%	28 Jul	31 Jul	28 Jul	28 Jul
DEVELOPING RECOMMENDATIONS			15 Jul	15 Aug	15 Jul	10 Aug
Identify Potential Markets	SADIQ	100%	15 Jul	15 Aug	15 Jul	10 Aug
Identify Growth Areas	TANVI	100%	15 Jul	15 Aug	15 Jul	10 Aug
Identify Innovation in Existing Markets	SUPREET	100%	15 Jul	15 Aug	15 Jul	10 Aug
Develop Concrete Steps and Framework that can be Taken	ABRAR, CHRISTY	100%	15 Jul	15 Aug	15 Jul	11 Aug
Propose Initiatives or Strategies that can be Implemented	WASIM	100%	15 Jul	15 Aug	15 Jul	11 Aug
Meeting with Clients on Progress	ALL	100%	31 Jul	31 Jul	31 Jul	31 Jul
REPORT AND PRESENTATION PREPARATION PHASE			1 Aug	18 Aug	1 Aug	15 Aug
Refine Business Report Draft	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Write Introduction	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Write Benchmarking Findings	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Write Survey/ Interview Findings	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Write Conclusions	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Complete Final Business Report Draft	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Create the Presentation Outline	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Finish Presentation Slides	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
Practise Presentation	ALL	100%	1 Aug	18 Aug	1 Aug	15 Aug
FINAL PHASE			18 Aug	31 Aug		
Presentation	ALL	100%	24 Aug	24 Aug	24 Aug	24 Aug
Evaluation and Feedback from Presentation	ALL	100%	24 Aug	24 Aug	24 Aug	24 Aug
Business Report	ALL	100%	20 Aug	31 Aug	20 Aug	1 Sep

OVERVIEW OF EXPERTS CONSULTED.



1. Tim Baxter

- Innovation and technology project manager at Babcock



2. Jamie Francis

- Graduate Aerospace Engineer at Babcock
- Research and Development Engineer at Babcock



3. Debbie Janson

- Senior lecturer at the University of Bath
- Business Development Manager at Horstman Defence system
- Industrial Engineer A350 Landing Gear
- Higher Research Engineer at BAE systems



5. Malek-El-Qallali

- Assistant Professor at the University of Bath
- Managing Director at Digital Émigré
- Strategic consultant at Strategic Innovation Ltd



5. Jens Roerich

- Professor of Supply chain innovation at the University of Bath
- HPC chair in supply chain innovation at the University of Bath
- Director, HPC Supply chain innovation Lab at the University of Bath
- Researcher at Imperial College Business school

EMAIL CORRESPONDENCE WITH INDUSTRY EXPERTS

E-Mail From the Group (7/11/23 – 7:50pm):

Good evening,

Hope this finds you well,

As you know, we are currently busy with practice projects, in particular we are doing one for Babcock which is an international defence company Headquartered in the UK. The project task is to evaluate the future of Babcock's products and services in light of technology, consumer behaviour, and market dynamics changes and the company's commitment to reducing carbon emissions and creating social value. One of the trends we've managed to outline so far is the continuing supply chain issues plaguing the aerospace and defence industry.

Considering this with the fact that Babcock is mainly an MRO company for defence assets but does have some manufacturing capability for type 31 ships using 3D printing, we had the idea of applying blockchain to get the usual auditability, security and decentralization benefits along the supply chain but also to enable new customer offerings through creating a 3D printing network built on blockchain which incorporates circular economic thinking. We've attached a couple papers on this for your consideration, we'd appreciate greatly your opinion on whether you think this is a road worth travelling on or not.

Thank You

Response From Malek El-Qallali (7/13/2023 – 12:25pm):

Hi Team,

I want to help if I can, but without stepping too much over your group, industrial supervisor and assessor.

3D printing, circular economy, blockchain etc., are fine. Still, I would be extra cautious of "applying or suggesting a direct solution" My only advice is about the mindset/approach rather than the actual offering. Suppose you want to "evaluate" the future of Babcock. In that case, it is about maybe showing the technology trend heading toward 2030, 2040, 2050 and so on, and if you want to talk about 3D printing, blockchain and other emerging technology, then rather than recommending technology to them, just present opportunities and challenges for each and leave it to them to decide. At least, that was my approach as a consultant.

Having said that, here is my own opinion (but this is personal and subjective based on my experience)

1. Blockchain application is mainly proven in a financial context, and some hopeful promises to combat modern-day slavery (either the two are directly applicable to Babcock)
2. A circular economy fits under sustainability, social corporate responsibility, and ethics - not the top three priorities for any organization in the defence space!
3. Opportunities can mean extended current capabilities (e.g., MRO and limited manufacturing) and exploring future prospects.

I hope this helps,

Kind regards,

Malek

Response From Jens Roerich (7/11/2023 – 8:09pm):

Hi Team,

Hope all is well. That sounds good. It might be worth having a table to compare/contrast different technologies and how they could address the company's specific issues might help. You could then consider how easy they are to implement etc.

Hope this helps.

Best wishes,
Jens

SUMMARY FOR TIM AND JAMIE QUESTIONS:

1. Would Babcock be open to providing 3D printing to other companies?

Jamie and Tim mentioned that at this point the 3D printing services are aimed at internal customers i.e., people within Babcock and as far as the partnership goes with other companies the scope is less. If it is commercially viable, they would consider providing 3D printing services to other companies. They have developed themes to understand and group customer requirements in terms of technology. They have portfolios of products and services they offer customers and the portfolios they wish to offer in the future.

2. What is Babcock doing on Battery electric propulsion?

Battery electric propulsion-They source vehicles to London Fire brigade and maintain them. They are responsible for sourcing and maintaining the vehicles. They have an ongoing partnership with Cranfield University where they are working on electric aircraft. Working as a system integrator for the army, navy, and air force for sustainable products.

3. Is Babcock implementing eco-friendly, sustainable techniques in 3D printing?

3D printing in general is believed to be less wasteful and an eco-friendly solution to traditional manufacturing.

4. Do you have any data collection practices across any of your manufacturing operations like throughput time, turnover time etc.? If so, how do you collect the data and what do you do with it?

They collect manufacturing data. Some of the equipment that they use is smart equipment and thus censored and for others they use a traditional recording methodology. With type-31 there are certain KPIs (key performance indicators) they must hit on monthly basis and the contracting mechanism report. The manufacturing process and delivery are driven by contract.

5. What kind of technology do you use in smart manufacturing?

Smart manufacturing – Invested a lot in Scotland on building type-31.

Machines that can measure sheets of metals. They have automatic cutting and welding machines. One end comes in as sheets of metal and the other end comes out as blocks.

6. How has the company changed in the last 10 years in terms of sustainability and social impact? As an employee, what kind of sustainability initiatives do you think that the company needs?

Sustainability Initiatives-Working with ethical suppliers. Conducting checks regarding how sustainable the other companies are. Limit the use of plastics as a company. Engaging with local community and suppliers.

Devonport football club. People volunteering for super kitchens. Be kind initiative. Net zero initiatives. Making efforts to meet the 2040 goals.

7. What is the most immediate change do you think the company needs in terms of social changes?

Societal Changes-Supporting employees. Encouraging the use of electric cars. Putting forth the idea of having Babcock's own transportation. Hiring younger and more diverse workforce who can bring fresh ideas to the table.

8. What rules and regulations should we keep in mind in terms of working with the MOD?

Challenges in safeguarding the data. Information security is an important thing. Moving information across the borders can be difficult. The reason American technologies were not used in the ships type 31 is the constant requirement of permission to use them. Efforts were made to minimize the use of American technologies.

9. What strategies do you use to integrate novel technologies?

Tools and tech process which would give info regarding assets. To provide predictive maintenance and analysis which is work in progress. Strategies to integrate technology which is case based. They are trying to understand what capability gaps in an organization are and what technology can help them fill those gaps.

10. What sustainability requirements does the government have on the use of the Type - 31?

There are contractual requirements regarding speed, range, and testing. There would be questions regarding these factors if the requirements are not fulfilled.

11 How do you measure the success of the MRO? What are the KPIs for successful maintenance?

Project management techniques. Each contract will have KPIs, and the project manager will measure the performance of the program based on the KPIs. KPIs vary from contract to contract.

12. How do you manage the supply chain for spare parts required for MRO Operations?

Spare parts- Dedicated engineers and supply chain team specific to contracts so you have supply chain operatives and can have regular meetings with them.

13 How do you ensure the timeliness of your MRO Operations?

Average project timeline-Depends on the technology readiness level. Getting around safety concerns and engineering issues as you put new equipment. Spend more time on safety cases and the impact that it will have on the ship. Customer demand can drive the timeliness and can accelerate the projects. Factor of safety is higher for military projects.

INTERVIEW-DEBBIE JANSON

- Wasim Manihar: [0:02](#) In your experience as a Value Engineer at Airbus, what are some of the strategies and methodologies employed to assess the cost-effectiveness and long-term benefits of adopting novel technologies in the defence sector?
- Debbie Janson: [0:06](#) Umm, everything is driven by weight because you can sell that more to the customer if you know if it is lower wage, it is lower cost to run for the customer. I don't think there were any particular strategies that people had other than you know, if you had an idea of a new technology that was kind of coming in, it had to go through many, many layers of technology readiness to be able to be deployed and more so than in kind of automotive or anything, you know, it would have to be really stringently looked at because if you know, especially on a kind of a high risk product like a tank or an aircraft, they won't take any risks at all. So, there has to be a real payoff elsewhere, and that might be in terms of specification and cost.
- Wasim Manihar: [1:27](#) That answers the question. Thank you.
- Debbie Janson: [1:28](#) OK.
- Wasim Manihar: [1:29](#) OK. So, the next question is when we are exploring new technologies, how do you balance the potential advantages and risk and challenges while implementing them? Like, what do you prefer? The risk and risk factor first, or do you think potential advantages are better?
- Debbi [1:43](#) I think you have to lead with the advantages because otherwise if you start with the risks, you are putting people off before they even have a chance. So, you have got to lead with the advantages, but I think being realistic is one of the main things, so we used to speak to a lot of technology companies that claim they could do. Umm I things like additive manufacturing when it was in its infancy. Yeah, in 10-20 years' time, we will be able to do these things, but it's very, you know, that forecast is very loose. So, some realism is really needed when talking about those advantages. So, yeah, being realistic. Did and kind of sell the advantages based on the complete specification? So, knowing your customer is key. So whilst like with the Airbus example, knowing that Airbus wants to save weight is one thing, but understanding why they want to save weight because it means their customers spend less on fuel and there's an environmental impact and that as well you know, it's not just about what that

specification is about, it's about the bigger impact. So, in defence it might be. I come up with an example, it might be that there is a technology that has better missile targeting capability for example, but the real impact of that is that you that you kill less children and civilians. So, making sure messaging is clear, the risks and challenges. Obviously, you have got to be upfront about those. And then the company must make that clear decision. Does that help?

Wasim Manihar: [3:54](#)

Yeah.OK. Our current company is Babcock, which is a defence company, and you worked for BAE, which is a direct competitor of Babcock. So, drawing from your experience at BAE Systems, what do you think such defence sector companies such as Babcock, what should their approach be while addressing environmental changes and implementing sustainable practices?

Debbie Janson: [4:23](#)

So, it is interesting because I am working on the Boeing project as well. That is the one I am looking after. And so, they have to do a lot of contractually on social impacts and social value. So, there is something in that about the way they position themselves so that people don't recognize them. If you think of Boeing, you do not think of bad, terrible defence company. You think lovely, commercial airline company and the same with Airbus. Most people associate Airbus with defence side of things whereas Babcock and BAE systems are very much defence and everyone knows that so there is something about the marketing positioning and how they sit within their communities and that is really important. But, yeah, there is an element there of what are one of the pillars of their value is sustainability one of those pillars, how do they demonstrate that and it is more than just what they actually do. There is a balance between what they are doing and what they look like they are doing and why does it look like they are doing it. So, one of our questions to Boeing was if you did not have to do all this social value stuff for your contract, would you do it? Of course, the answer is no, I mean, they would not say that. There is a certain amount of corporate social responsibility that they have to do but beyond that would they really do it?

Wasim Manihar: [6:19](#)

Answers. Yeah OK, now you talked about social impact. So, we are giving a recommendation of the social impact of hiring more veterans in the hiring process and any other activities such as emergency services. And we had a talk with one of the representatives and we learned a lot about that 10% social value during the bidding process. It helps you get the contracts. So, do you think this initiative might help in getting the contracts like increasing the veteran's workforce?

Debbie Janson: [6:50](#)

Yeah, yeah, there are loads of things you could do. So, you should speak to the Boeing team because their project is about what this

social value element of the contract could be like. So that is anything from, as you say, employing more veterans to providing computers in local schools so that they can do more STEM training. I mean, they have about 200 things on the list that you could dig into. So yeah, and it's how Babcock defines social value and what they would like their impact to be. And it is my understanding it depends on where the contract level is, it's always roughly about 10% of the contract value that they want to kind of commit to social value improvements. Umm, but making it again. It is also done with how they sit within their community as well. So, umm, you know, youth and more local suppliers or force in their supply chain to use more local suppliers and those sorts of things. So yes, there's loads of stuff in there. Talk to the Boeing team.

Wasim Manihar: [8:03](#) So, our next question is one of our recommendations is just in a complying the battery electric propulsion and the defence sector in marines and aviation. Do you think that is possible in the near future? Do you think that is possible in the near future? How do you think of different sectors adopting this technology?

Debbie Janson: So, but battery operation in aviation or just Marine.

Wasim Manihar: Yeah, and marine both.

Debbie Janson: OK umm

Wasim Manihar: [8:30](#) Kind of hybrid and single alarm kind of work.

Debbie Janson: [8:31](#) It's a good question. I mean, it feels like kind of because it is in automotive now, like battery powered stuff is everywhere, but what do you want your aircraft flying with it? I do not know. It's down to that risk and pay off risk and rewards. You know what are the benefits? It really got to sell it over the fuel because as much as they want to be seen to be caring about the environment and sustainability. They maybe, you know, there are other things that like cash talks, right? If people are still going to pay them to provide kind of, you know, fuel for their aircraft, then it is about how they sell it to their customers as well. So again, kind of you have got to complete that chain. It is not just what your customer is immediately going to think. What is completely proven is still not necessarily acceptable to the customer, which is an issue.

Wasim Manihar: [9:43](#) That's nice. OK. So, our next question is, given your extensive experience in various defence roles including cost and pricing engineering, how do defence companies like Babcock and BAE justify their investments and pricing in these things?

Debbie Janson: [9:59](#) So, when I worked at Horseman defence, which is they provide tanks suspensions. Basically, that's tanks, expenses, and mobility solutions. All our investments were paid for through contracts. So, if somebody wanted, you know, 100 tanks suspensions and we were going to have to commit £10 millions of investment, we would spread that cost or we would just charge the customer. Everything was paid for by the customer. Very little was paid for internally. Yeah, I other than kind of the buildings, but even the buildings and everything that was all spread into the kind of overhead rate that we would then charge back to the customer, so. Yeah, I would say everything was funded through contracts. Do you need more information on that?

Wasim Manihar: [11:20](#) That's ok and we just want to know what the decision-making processes on these things are?

Debbie Janson: [11:23](#) OK so. In most companies, most defence companies, there is a kind of tender process where you will remember that from my lecture. Of course I was close and as part of that will be a kind of capital expenditure specification and it there's always that decision making process of are we are going to fund this or are we going to ask the customers to fund it normally the customer but there might be things that say if we if we want to buy a new machine that will machine things 10 times as fast then we will purchase that ourselves because then we can make benefits across the range and we'll see the payback so it's all about a kind of return on investment calculation and convincing people that don't want to be convinced because they don't like change again even if the numbers stack up sometimes that's not enough but there will be quite a stringent process normally that people go through. It'll vary from place to place, but it will be based on return on investment and risk. Everything.

Wasim Manihar: [12:40](#) OK, so this is our next question. So, we have a meeting with the CTO of the Babcock and. We were like, thinking, how do we approach him? How he should invest in these novel technologies What should our approach be like in this market and with its stakeholders? How should we manage them? Quite hard to like. Impress the CTO on these things when he knows a lot on these things.

Debbie Janson: [13:09](#) Yeah, yeah, yeah, I think so. He will know a lot, but you're all you know. You've also been working on this project full-time for a couple of months, so he may not know everything you know, otherwise you would not be asked to come in, right? So. And so, are you aiming to basically tell him of some technologies that they should be using in their business?

Wasim Manihar: [13:27](#) Yeah

Debbie Janson: [13:28](#) OK, so that's fine. You just need to be clear on the kind of risk benefit. I mean, even call it a risk benefit analysis and what they will always come back with is how much is it going to cost me and what is the risk? I mean, that's the obvious thing. So, if it was your business how much you want to know how much it's going to affect your bottom line? What happens if you don't do it? It's important because if you think these are good ideas and don't take them up, what if they're competitors? Take them up. What if they do nothing? What if they just stand still? So, it's not only the risk of taking up the technology, but also the risk of not taking up the technology as well. If you've got examples of other companies or other industries that have used the technology successfully, so it is not it, it might not seem comparable to talk about automotive using electrical propulsion. But actually, it's a proven process that now automotive embraced and. And used as a find that it more acceptable and all those sorts of things. So it's how those journeys happened, and you might say in automotive that journey began 40 years ago. I've no idea. I'm just making a number and it's taken 40 years to get it to this point in what is a relatively low risk environment. So that might give you some ideas of timelines for taking it forward into defence, for example. So yeah, I think evidence is helpful. Don't make things up if you don't know. Just say we don't know, but we think it's a good idea. But have justifications and remember the CTO is probably going to be an engineer. Very interested in how things are going to meet a specification and not too worried about people's feelings in the same way as with I was going to say CEO or CFO, I mean CFO is all about the numbers, but CTO is more about how this is going to solve my problem in a proven way.

Wasim Manihar: [16:09](#) That's nice. That are some good insights' the next question is like we have two more recommendations, which is Bio-LNG and WHR. Do you think this technology is applicable in the marine?

Debbie Janson: [16:24](#) Tell me about them

Wasim Manihar: [16:25](#) As by we are just suggesting them to retrofit for the bio-LNG instead of LNG because more sustainable and cheaper a little bit. And the WHR you using the excess heat from the shapes for heating, cooking, and all things, do you think this is applicable or mature enough to apply? Research says it is applicable soon.

Debbie Janson: [16:44](#) They feel like don't have suggestions that I might call. Again, the things that have been used in other industries, so there is no reason you could not translate that across. But again, having evidence of those things to support it would be important.

Wasim Manihar: [17:15](#) Thank you. OK. Just two more questions for not that one, sorry.

Debbie Janson: [17:16](#) That's alright

Wasim Manihar: [17:17](#) OK. So, defence platforms often have very long-life cycles, like to even for the from the implementation to the idea to the high scale. how do these companies balance new technologies or current technologies? Like, how do they integrate them? Like, how do they ensure that we are on the correct track? We're not getting that bifurcated by new technologies and other than that.

Debbie Janson: [17:37](#) Think it's all to do with the research and development process and just make sure that you're right. It's a lengthy timeline. You just kind of 10-20 years like things that I was working on when I was at Horseman defence. How many years ago was that like 15 years, maybe 10-15 years? They will only just be starting to be produced now. So, which is mad, right? So, you've got to have some foresight of the technology and take some risks. So, when you're bidding on work, for example, you will include, you know, we are intending to use these technologies. If those technologies fail or you know like in COVID, there is suddenly a massive chip shortage. There's got to be a contingency in there. So, you are, and it is all about how you balance that contingency then. So, if we had to revert to old methods or more historic proven methods you don't then want to be out of pocket. And realistically, if you propose that you are going to use a new technology and then you signed a contract at some point further down the line, if you find out you can't use that, this is very, very unlikely that your customer is going to say is cancel the contract and go elsewhere. Then more than likely going to work with you to find a way around it. Because that is just the easier route. So yeah, I think that there's an element of risk there. They must have this kind of long-term. A few of why the technology's going and keeping an eye on other industries. I'm quite often other people will be working on things you know it like the propulsion side of things. Do look at other industries and keep an eye on what's happening, but you'll know it's coming. You know things that I was looking at Airbus 20 years ago. Uh, there, there are a lot further on than you might, but then publicly you might think there's lots of stuff that goes on very secretively

Wasim Manihar: [19:56](#) Thank you. So, like in your view, what are the potential regulatory and certification challenges this defence companies face when they are introducing these new technologies?

Debbie Janson: [20:08](#) I think it's tricky because it depends on what sort of industry within defence. So, if you if you're looking at anything in aviation, the certification, it could take 20 years to change the certification. So, you know, if there are certain materials that are, uh, viable for aircraft parts for example, you've got to get them certified and

tested. Even the material that can take three to five years. So the regulatory issues can hold things up, but in my experience what happens is the defence companies are very kind of aligned with the bodies, so that if they can see a new technology, they're very influential and they all kind of work together and they can change the regulation for the future as the new technologies are being implemented. I'm but yeah, it can be prohibitive.

Wasim Manihar: [21:10](#)

Thank you. Well, in your experience in defence companies, how do you see adoption of these green technologies influencing the competitive landscape like they are very competitive, you know different sectors?

Debbie Janson: [21:21](#)

Hmm, I think so. In the same way that the social value element is part of the contract, I think that will. I'm sure there's an element in there that there's this sustainability element so that that is kind of I think if it came down to a like for like bid and one company was offering a greener solution, there is no doubt in my mind that that bid would be the preferred option even if there was some price difference. You know, again, that's just my opinion. There has got to be a scale there of if it is 5% more, but it is a green solution, you know, where is that? What percentage does makes it OK? Umm, I think there's pressure on all companies now, though, to do things in a sustainable way, especially if they its outward facing. They need to do these things.

Wasim Manihar: [22:40](#)

OK. The last question from me as a professor and industry expert. What recommendation would you give to the defence industry seeking to establish sustainable and social impact in the industry? What recommendation would you give to the defence industry seeking to establish sustainable and social impact in the industry?

Debbie Janson: [22:56](#)

I think it is something that they all need to oh, there it is. They all need to get on board with it. It's not going away. It is kind of critical pillar of their business really to operate sustainably I'm and authentically, so they don't just do it because the government tells you to do it. Yeah, and it's really clear when people are doing it for the right reasons. So just an example I visit a lot of PPE companies for my research. So, I went to see one only an hour away in Chippenham for half an hour. A few weeks ago, when I arrived there, the visitor signed in forms. They asked me how I was going to offset my journey that day. I know, right? And to me, that is like an authentic way of doing it. hey're not just putting a badge on their website saying they are Committed to green. They're actively doing something about it. So, and if I can't offset it, they will offset the journey for me. So, I thought small things like that send good messages. Yeah, authenticity.

Wasim Manihar: [24:21](#)

Do you mind if we quote you in the report?

Debbie Janson: [24:22](#) Yeah, you can quote me.

Wasim Manihar: [24:30](#) Yeah. All right, we will try to do that. Thank you so much. Sadiq has some questions.

Debbie Janson: [24:35](#) Yeah. Go for it.

Sadiq [24:36](#) Yeah, I have one more question. I was wondering specifically about your experience in the defence industry when a firm is in the business of performing maintenance or even manufacturing things. How complex is this supply chain in terms of share number of participants to get a pass for either, maintenance or manufacturing. So that is one and the second account that's linked to that is like in your experience in the defence industry. What were some of the major challenges you found in terms of this, the supply chain?

Debbie Janson: [25:34](#) OK, so from the first one? We like to keep the supply chain quite short because then it is less risky. So and it's very difficult for new suppliers to break into supply chains in defence because if there's any, if there is any certification issue and you know you need to maintain quality standards for example, you don't want to introduce a new supplier and have your reputation ruined. I mean, it's the same everywhere. I guess the way we used to do it would be to introduce a dual supplier, so we'd keep our current. If somebody said, oh, I could do that 50% cheaper, then we'd give, we'd trial them and we might introduce a dual supply relationship. And that also if they were successful, that was a really good opportunity to reduce the risk over all of them because we still keep the expensive people on because we know they were solid. But if we had an issue with either supplier, we knew that we or we had, you know, an increase in volume. We could kind of turn to both, but keeping them, keeping them a very the supply chain overall, you know, very limited numbers. And making sure that we weren't there, the whole business was really important because we needed them to have other business because we didn't want to be responsible if we pulled out. We don't want to kill their business, so there was some kind of a sustainable element of that to make sure that we were keeping people going. Does that answer the first one? Ohh I was probably going to say maybe it's answers the second one as well. Actually, the main challenge on the maintenance side and the kind of ongoing service was obsolescence. So, parts that because of these long and of service contracts we might be for tanks, for example an aircraft, their life can be 20-30 years or longer. But trying to find an overring that went on a certain past 20 years ago. That is no longer manufactured. It was a real problem so. Or, uh, supply is going out of business. So the bigger parts or the kind of

more you know, everyday things not an issue, but when you've got a certain gauge or an o-ring or a copper bus or something like that, that was made by we used to call them Ted in a shed that's the kind of the one man bands trying to get somebody else that could make those things for a reasonable cost as well because your customer still wants to pay what they've always paid even if that was 15-20 years ago. So yeah, and I think there's a lot more now about kind of protecting that supply chain for the future as well and understanding where obsolescence might come in, umm, so and then what was the second one, just challenges working with the supply chain? I think one of the main challenges I encountered was people making changes like not following drawings. Basically, just making changes and not appreciating the impact of that which you would think like. Why makes a change? Just follow the drawing. But people sometimes think they're being helpful. I was genuinely helpful and they're not this one time when I was at Airbus and one of the composite panels on an aircraft have been delivered and it didn't have the holes predrilled in it for the rivets to go through. So, somebody just took a drill on the assembly line and just drilled the holes and I you can't do that because there's it kind of splinters all around the composite around the hole, and then that makes it more prone to failure and things. But there's a guy on the line. Just thought he was being helpful and didn't want to report problems. Didn't want to get the supplier into trouble? So yeah, people just take it into their own hands. So, understanding the consequences within the chain was important. And yeah, the opposite lesson thing was key. But also, yeah, I think it's just it's the same issues in defence as art, defence, just people not realizing the impact of like lateness or poor-quality sending stuff anyway and hoping that no one notices. So yeah, I've seen lots of that was stuff arrives in the warehouse and it's poor quality and you bring them up and you say surely you saw this and they said, yeah, but we hope you wouldn't notice like, like what? Ohh yeah, we're going to notice. Umm yeah, they're all the usual.

Debbie Janson: [30:51](#) That's OK, but any other questions?

Wasim Manihar: [30:58](#) And. No. Thank you so much for taking the time.

Debbie Janson: [31:02](#) That's OK. I hope it's been useful. I feel like I've just waffled at you, and if you have any.

Wasim Manihar: [31:06](#) It was very useful. Sorry for ambushing you. It's so complicated questions.

Debbie Janson: [31:09](#) No, that's OK. It's fine. Some have you got any other questions at any point? Let me know. Umm yeah.

Conversation With Defence Industry Expert – Debbie Janson

DETAILED SWOT ANALYSIS

Strengths: Babcock stands out with its commitment to emissions reporting and a diverse product lineup. The company adheres to Global Reporting Initiative (GRI) Reporting Standards, reflecting ESG disclosures in their annual reports (Babcock GRI Report, 2023). Their extensive engineering services encompass naval, nuclear, and aviation engineering, pivotal for national defence (Babcock, 2023). The company boasts a strong contract backlog, totalling £9.4 billion in FY23, with 78% from the defence sector (Babcock Full Year Results, 2023). Notably, Babcock excels in MRO services, generating £4.4 billion in FY23, a rise from £4.1 billion in FY22 (Babcock Full Year Results, 2023).

Weaknesses: Comparing Babcock to peers exposes stark R&D discrepancies despite higher revenue. Meggitt's revenue in 2020 and 2021 was £1.6B and £1.4B, allocating £70M and £97M for R&D, respectively. QinetiQ earned £1.3B and £1.2B in 2022 and 2021, investing £302M in R&D in 2022. In contrast, Babcock's revenue for 2022 and 2021 was £4.1B and £3.9B, with meager R&D investments of £2.6M and even less in 2021 (Meggitt Annual Report, 2021; Babcock Annual Reports, 2022). The company heavily relies on the UK MoD, with 67% of revenue from them in FY23 (Babcock Full Year Results, 2023). Operating profits dipped despite organic growth (Babcock Annual Reports, 2023).

Opportunities: The UK defence sector flourished post the Ukraine conflict, with £55.5 billion allocated for defence in 2022/23 (HM Treasury, 2023). A 3% of GDP commitment by 2030 beckons significant defence spending (Chalmers, 2022). The UK MoD's strategic reports signal investments in new technologies, like unmanned aerial vehicles, alternative fuel propulsion, AI, and space systems (UK MoD Science and Technology Portfolio, 2023; Strategic Command, Sustainable Support Strategy, 2022; UK MoD, Defence Technology Framework, 2019) with competitors like BAE Systems, Boeing, and Lockheed Martin already offering these services (BAE Systems, Boeing, and Lockheed Martin Annual Reports, 2022/23).

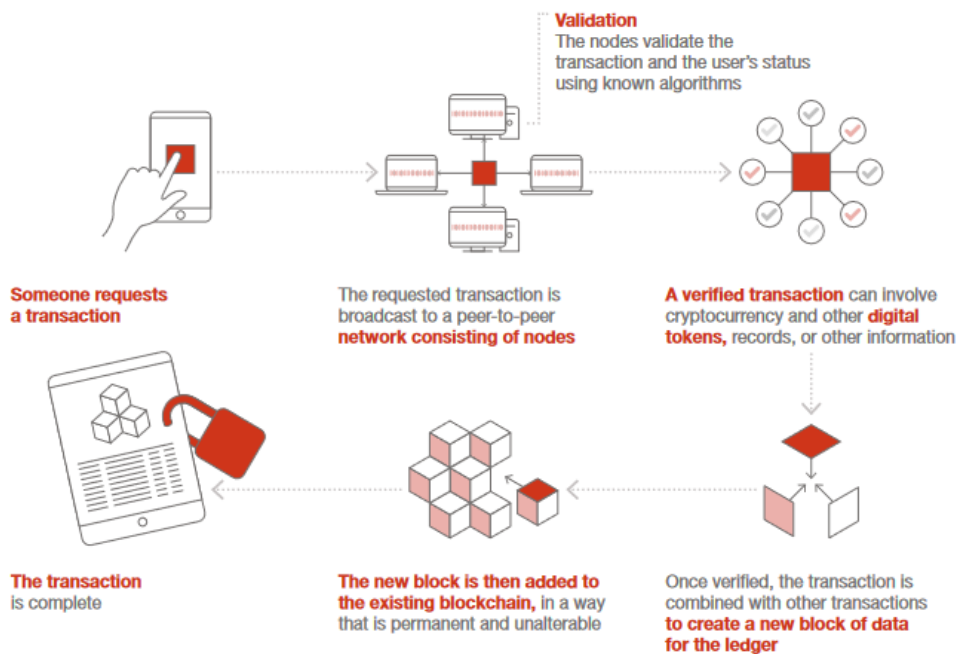
Threats: Fierce competition from major players such as BAE Systems and Lockheed Martin strains the aerospace and defence sector (MarketLine, 2021). Political uncertainties and supply chain constraints, as exemplified by the Russian titanium supply issue due to the Ukraine war, pose threats (Deloitte, 2023). Furthermore, non-traditional defence companies like SparkCognition and OdySight AI offer unique products and capabilities and pose a significant threat (Decker and Li, 2023). For instance, they provide novel blockchain and AI technologies for UAV operations.

OVERVIEW OF KEY TECHNOLOGIES, BLOCKCHAIN, AR, ETC.

The Blockchain

Blockchain is a distributed ledger technology that enables the recording and sharing of information within a community. It utilizes a decentralized peer-to-peer network to store and record transactions and data in a cryptographically linked block structure (Rodriguez et al., 2018; Ahmad et al., 2021). While commonly associated with financial transactions, blockchain can also be used to record various activities, such as the installation or removal of parts in defence assets like jets and frigates (PwC, 2019). This technology has the potential to address long-standing issues in the aerospace and defence industry, including part location and availability, supply chain management, maintenance certification, contract execution, payments, and emissions tracking (Aerospace

How blockchain works

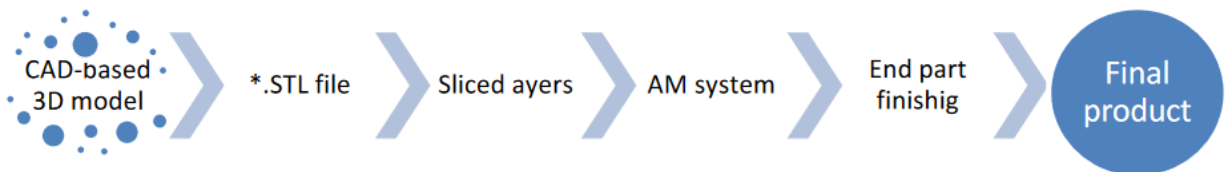


Overview of How the Blockchain works as presented by PwC (2019)

Additive Manufacturing

Additive Manufacturing Involves an iterative process of building objects, layer upon layer, from a 3D modelled data rather than subtractive manufacturing methods like machining, helping to create intricate designs that are difficult to make using traditional methods, saving enormous amounts of time during product design and development stages, and reducing waste (Rodriguez et al, 2018).

In the defence Industry one of the key value propositions for 3D spare part manufacturing is the reduction of the overall logistics chain and the need for storage facilities of spare parts as it provides the ability to manufacture parts on demand locally and increases flexibility. It also has the ability to produce parts at the time the demand arises in-theatre or at a forward operating base (FOB) close to the location of use, which can reduce the overall lead time, as the parts do not have to be transported long distances and also produce only the volume required (González and Álvarez, 2018 & Stavropoulos, 2022).



Visual representation of the Additive manufacturing of a turbine (Tabaković and Duraković, 2020)

Internet Of Things, Big Data Analytics and AI

Internet of Things (IoT) refers to a coming together of advanced software, cost-effective sensors, and network connectivity that allows objects to interact digitally (Rodriguez et al, 2018). The IoT layer plays a “Hardware Oracle” role that interacts directly with hardware devices, such as RFID chips and IoT sensors to create substantial amount of verified data points(Ahmad et al, 2021) known as “Big Data”, this allows for Big data analytics involving statistical examination and analysis of data that goes beyond generic data intelligence gathering to unearth deep, actionable insights and make predictions on an autonomous or

semi-autonomous basis using Artificial Intelligence computer systems that use machine learning to improve their performance by exposure to the aforementioned data clusters(Rodriguez et al, 2018).

Augmented Reality

Augmented reality is a technology which overlays digitally created content into the user's real-world Environment, it works through wearables that enable users to take real-world actions by providing relevant, contextual information precisely at the point of decision making (Rodriguez et al, 2018). In the A&D industry augmented reality will aid engineers in the development of new technologies as well as the maintenance of assets by including 3D graphics/simulations for whatever is being worked on, it can be used for remote maintenance, maintenance training and can greatly improve communication in product design and production development (Stavropoulos, 2022).



Augmented Reality interface as presented by (2022)

Implementation Plan – Babcock 4.0

Digital capabilities are crucial for Babcock to move into Industry 4.0, and these capabilities usually take some time and require an iterative development process (PwC, 2016):

In the Now (4-5 Years):

Babcock should clearly map out its Industry 4.0 Strategy: Assess your current digital readiness and establish well-defined goals for the next five years. Identify fresh ways to generate revenue and reduce costs. Prioritize actions that yield optimal value, aligning with your broader strategy. Ensure strong leadership endorsement. Clearly articulate and share your digital vision. Develop not only a digital strategy but also the necessary tools to empower and steer its execution. (PwC, 2016)

Babcock Can create initial pilot projects: start by identifying important operational components that are ready for innovation. For each pilot project, Babcock should set clear goals and quantifiable outcomes before choosing suitable technology, such as augmented reality, artificial intelligence, blockchain, and others. There should be an adequate allocation of resources and experience, as well as thorough project plans and timetables. The company will be able to carefully monitor and gather performance information by carrying out these initiatives in controlled environments. The business may then evaluate the findings, make strategic adjustments in light of the knowledge gathered, and scale up successful pilot initiatives while using the lessons discovered to provide a broader transformative impact. (PwC, 2016)

Babcock Should determine the skills and capabilities it requires: Detail the skills you need to realize your goal, building on the knowledge gained from the pilots, including how all of the company processes can be substantially improved by Industry 4.0 enablers, such as an agile IT infrastructure and data governance.

Strategies for attracting top talent should also be given significant consideration. (PwC, 2016 and Lineberger et al, 2019)

In the Near Future (6-10 Years)

Implement Industry 4.0 Strategy: Collect, analyze, and utilize data for optimization, provide employee training, collaborate with experts, implement robust cybersecurity, and ensure continuous improvement while gradually expanding operations. Find ways to leverage these technologies to unlock new customer insights and improve customer engagement while monitoring evolving customer needs, preferences, and shifts in demand.

Make Assets Intelligent: Use industry 4.0 technologies to make assets smarter and more self-aware, Establishing seamless connectivity between systems, devices, and data sources and maximizing utilization and efficiency (Lineberger et al, 2019).

Create New Services and Platforms: Leverage 4.0 technologies into opening new opportunities for Babcock like creating shared 3D printing hubs using blockchain, optimizing maintenance with AI and AR and creating MRO operations for UAVs. Collaborative partnerships and regulatory compliance can also enhance innovation and value, positioning the company at the forefront of defence asset management. (Lineberger et al, 2019)

In the Future (11-20)

Implement an ecosystem approach: Integrate the Industry 4.0 initiative with ship WHR, Ship Bio-LNG retrofitting, and ship battery electric propulsion maintenance services to form a synergistic ecosystem. Centralized data sharing and advanced analytics will optimize efficiency across projects, enhancing predictive maintenance, energy optimization, and resource allocation. Cross-project training cultivates versatile expertise, while ecosystem partnerships ensure alignment with industry standards. A unified strategy underscores the collective impact on sustainability and operational excellence, positioning the company as a holistic provider of advanced maritime solutions. (PwC, 2016)