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The European Land Force Commanders Organisation

FINABEL - THE EUROPEAN LAND FORCE COMMANDERS ORGANISATION

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Introduction

Circular economy principles are already widely adopted in the civil sector, however, the defence sector lags behind, facing several challenges that hinder its uptake. Western countries are increasing defence expenditures despite financial constraints, resulting in a steady rise in carbon emissions from military processes. Circular economy practices, which are not yet widespread in this sector, present an attractive long-term solution to both these concerns. In a turbulent security landscape, amid an environmental crisis, a shift from the 'take-make-waste' (Knight, 2023) approach to a circular economy model is crucial as it offers the sector economic resilience, autonomy, operational efficiency and civil-military synergies in times of instability, strengthening the sector overall. As the European Defence Agency argues, 'strengthening Europe's security capabilities is a challenge that requires strategic planning and an efficient use of resources' (Katainen, 2016). The Incubation Forum for Circular Economy in European Defence (IF CEED), established by the European Defence Agency in 2021, plays a crucial role in applying the circularity principles of the EU Green Deal to the European defence sector (European Defence Agency, 2023). The goal of the IF CEED is to apply principles and policies from the civilian sector to the defence sector, under the premise that a European circular economy can only be achieved through the participation of all sectors (European Defence Agency, n.d.). This paper starts with the definition of circular economy. It then analyses the current state of military expenditure and carbon emissions. Finally, it presents three project ideas of the IF CEED - Circular Data, Additive Manufacturing and Circular Materials for Textiles (European Defence Agency, n.d.) and the value they bring to the European defence sector.

Current State of Military Expenditure and Emissions

By adopting a circular economy approach and shifting away from the traditional 'take-make-dispose' model (Knight, 2023)., the European defence sector can enhance its economic resilience, reduce military emissions, reduce supply chain vulnerabilities, and strengthen the autonomy of the sector. The European Union defines a circular economy as a "system which maintains the value of products, materials and resources in the economy for as long as possible, and minimises the generation of waste" (European Union, n.d.-b).

The focus on resource efficiency, sustainable production, repair, reuse, refurbishment, and recycling (RRRR) marks a turn from the linear economy that prioritises the 'take-make-waste' approach (Knight, 2023). The European Commission introduced the first European circular economy plan, 'Closing the Loop', in 2015. However, it was not until the following year that the Commission announced plans to apply this same economic principle to the defence sector (European Commission, n.d.).

As global military expenditure and emissions are expected to continue rising amidst a deteriorating security landscape, a shift to a circular economy becomes important. Sustainable production, resource efficiency, RRRR and innovation are critical components of a circular economy and can all assist in creating more autonomy and supply chain resilience. This transition can assist in manage-spending and reducing supply chain vulnerabilities in unstable geopolitical conditions. In 2023, NATO members accounted for 55% of global military expenditure, with most European members independently increasing their spending (Stockholm International Peace Research Institute, 2024). During periods of instability tariffs, prices and shipping routes are more subject to change. The ongoing conflicts in Ukraine and Gaza, and escalating tensions in the Asia-Pacific underly the need for strategic autonomy. Therefore, by adopting circular economy principles such as RRRR in defence, the sector can increase its autonomy and reduce reliance on other regions for critical raw materials, technology and supplies.

Enhancing the transparency of carbon emissions reporting within the defence sector can catalyse a greater shift toward a circular economy, by increasing accountability and simultaneously supporting the case for this transition. The global defence sector accounts for an estimated 5% of all global carbon emissions (Scientists for Global Responsibility, 2023, 9). Unlike the civil sector, historically, the European defence sector has been exempted from environmental regulations to guarantee operational efficiency and military readiness in peace and wartime. Parties of the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris Agreement must report annually to the UN on their carbon emissions. However, reporting on military emissions is voluntary. In fact, some states have fewer obligations to the organisation if they do choose to report(Mcfarlane & Volcovici, 2023). The circular economy of Europe as a whole relies on the contribution of all sectors and industries. The “military emissions gap”, described above lacks transparency and complicates the EU vision of achieving net zero by 2050 (Military Emissions Gap, n.d.; European Commission, n.d.), in addition the economic benefits and autonomy it provides.

A circular economy offers the defence sector a pathway to environmentally sustainability and economic resilience amid times of instability. This approach must include innovation, sustainable supply chains and improved in reporting transparency to maximise its benefits.

Recycling & Circular Data

Circular economy practices such as the transition from the programmed destruction of military equipment to innovative solutions offer significant benefits for the European defence sector. Practices including material extraction and data sharing, reduce costs and enhance industry interoperability, while also moving towards sustainable resource management. Military equipment and components have a limited life span after which the material degrades and becomes ineffective or unsafe for use. Often military equipment, including uniforms are destroyed after this period of time to prevent it from falling into the hands of unauthorised individuals who might misuse it or pose as military personnel. The Dutch Ministry of Defence previously incinerated uniforms and specialised

gear after use, costing €500,000 annually. The Government's Clothing and Personal Equipment Company (KPU company), has begun textile recovery efforts to extract re-useable material, generating €750,000 in revenue for the Ministry and minimising CO2 by 14,500 tonnes and revenue (European Defence Agency, 2020). Similarly, a body armour insert is traditionally incinerated at the end of its lifespan of 5-10 years (European Defence Agency, n.d.-d). In the UK, manufacturing a set of body armour costs £3000 each, indicating a significant financial incentive for efficient recycling practices. (The Defence and Security Accelerator UK, 2023). The recycling of body armour sets is complicated as under many jurisdictions it is a controlled equipment (Custom Armour Group, 2024). Additionally, this type of equipment may have been exposed to hazardous material, possess confidential identification, and must be recycled in a way that it cannot be reconstructed (Custom Armour Group, 2024). As a result of these complications, new methods must be adopted to assist in potential recycling or re-use, to avoid the 'simpler' option of decommissioning through programmed destruction.

New innovations such as the Digital Product Passport can mitigate some of the challenges associated with recycling or reusing military equipment. It also marks a significant step toward cost reduction, industry-military collaboration, resource efficiency and operational performance of the defence sector. The Digital Product Passport embeds key information on the product such as its origin, composition and lifecycle through IT Architecture and a data carrier, e.g. QR code or digital watermark (European Defence Agency, n.d.-d). This January marked the launch of "IOTA 2", the application of a Digital Product Passport for body armour components by the European Defence Agency (European Defence Agency, 2023). Circular data can contribute to taking better care of the product, research on expanding its lifecycle, or reuse following its expiry. In turn this will harness innovation and result in more efficient resource use, waste and cost reduction. Developing a standardised data exchange system is also fundamental to managing a product's lifestyle and, therefore, enabling the creation of a closed loop (Incubation Forum for Circular Economy in European Defence n.d.; European Defence Agency, n.d.).

The project is being tested for a year by Luxembourg, Germany, Spain and France, in collaboration with major technology, engineering and consulting companies from each state (European Defence Agency, 2024). The IOTA 2 project marks an opportunity to strengthen the relationship between EU member states and the defence and civilian sectors. Collaborating with diverse industry providers will create new opportunities for innovation, such as reusing valuable ballistic protection materials such as ceramic and aramid from amour inserts (Incubation Forum for Circular Economy in European Defence n.d.; European Defence Agency, n.d.). Aramid fibres are incredibly strong and heat resistant synthetic fibres that provide protection from projectiles such as bullets (GAB Neumann, n.d.). This type of fibre is estimated to be 85 times more costly than steel (The Defence and Security Accelerator UK, 2023). Uplift360 is a start-up run by Veterans in the UK, and it is currently using sustainable chemicals to convert these fibres to virgin material, which can then be used to produce helmets, flame-resistant clothing, gloves or fibre optics (The Defence and Security Accelerator UK, 2023). The IOTA 2 project has also outlined the future potential for this fibre to be extracted from the expired body armour inserts, in replacement of incineration.

Digital Product Passports have already had several successful applications in electronics, automotive, textiles and construction industries. However, the same concept encounters data security concerns and complex supply chains when applied within the defence sector. However, once a suitable method has been tested on body armour inserts, it can be applied to other forms of military equipment. Enhancing circular data through Digital Product Passports will provide a competitive advantage to the sector by fostering innovation, reducing long-term costs and strengthen data and industry interoperability.

Additive Manufacturing

Innovations in additive manufacturing, (commonly known as 3D printing), can contribute greatly to fostering a circular economy in the defence sector and in parallel support operational and logistical efficiency in the sector. The ICFEED project idea for "Circular Deployable Additive Manufacturing" for onsite / in-mission manufacture or repair of complex military parts will reduce logistical footprints and increase the self-sufficiency, and operational readiness of European military missions (Incubation Forum for Circular Economy in European Defence n.d.; European Defence Agency, n.d.). Additive manufacturing is the process of "manufacturing … complex geometries and structure by adding material in layer form, using 3D model data" (Mellor et al., 2014). The delivery of military parts can often involve expensive shipping or delivery with high carbon emissions and by producing parts on site through mobile additive manufacturing, logistical footprints can be reduced.

Mobile additive manufacturing can produce on-demand spare parts, medical devices, armour and components for aerial reconnaissance and UAVs (Incubation Forum for Circular Economy in European Defence n.d.; European Defence Agency, n.d.) on missions. Additive manufacturing can also offer real-time monitoring by embedding smart technologies into various structures, such as communication devices, and energy-harvesting technologies into amour systems (Colorado et al., 2023). The technology offers significant advantages by reducing strain on supply chains and increasing flexibility and security in remote areas since it can manufacture the components required by forward-deployed units without the need to ship them from the logistical rear. Operational benefits complement a reduction in emissions, as the process uses fewer materials, requires less recycling and minimises the transportation of products. Despite this, if parts are going to be produced regularly via mobile additive manufacturing, a process of quality control would be required to ensure all parts are standardised.

Additional challenges arise from the security threats that this powerful technology presents if it falls into the hands of adversaries. As a dual-use, affordable, and mobile technology and not yet heavily regulated, it can be used by non-state actors and criminals for terrorism and even nuclear weapons (Fey, 2017). As components required for military or nuclear equipment can be manufactured domestically, without being dependent on major producers or traditional governance limitations, additive manufacturing may incentivise small states or non state actors to invest in nuclear programs (Rostker, 2023). Additive manufacturing mitigates the reliance on supply chains, offering significant financial benefits for potential users.

The risk of misuse is amplified by the digital aspect of additive manufacturing. Computer Aided Design (CAD) Software feeds the additive manufacturing machine a design to 'print'. This software is readily available for download, along with CAD files. If CAD files for dangerous weapons become available, this digital aspect becomes a huge risk for cross-border threats (Brockman, 2018). Additionally, using non-conventional materials such as plastics for weapon manufacturing constitutes a threat as they could possibly bypass traditional metal detectors, both in military and civilian space (Freskos et al., 2024). While the ICFEED project group on additive technology may offer several economic and operational advantages for European military forces, there are also emerging threats for European security. For that purpose, states and organisations need to collaborate to ensure that this technology "matures into an asset rather than a liability for nuclear energy programs" (Rostker, 2023). The technology will provide a competitive edge, yet research and regulations are necessary to avoid emerging threats.

Smart Modular Protective Clothing

The textile industry in the EU is the third-highest consumer of water and land use, and the fifthhighest consumer of raw material and emitter of greenhouse gas (European Environmental Agency, 2024). The recycling of military textiles used in personal protective clothing, uniforms and defence systems including tents, camouflage tarpaulin and parachutes is a complicated process due to contamination acquired during training and operations (Adanur, Tewari, 1997). However, RRRR is essential to reduce overall costs, the transfer of pollutants to the environment and the consumption of water and energy during production.

The IF CEED Project Circle 'Circular Materials for Textiles' provides several operational benefits to the armed forces, while also improving interoperability through standardisation. Personal protective clothing (PPC) lasts 10 years and with the rising army recruitment numbers, this poses a significant financial burden. High-value materials are used to protect soldiers from environmental, chemical and biological threats such as heat or cold fatigue. Given that, the project aims to invest in smart and sustainable design, to decrease the carbon-footprint of PPC, while reducing spending and operational competitiveness (European Defence Agency, n.d.-e).

The expected outcome of this project is the development of smart textile structures and systems that offer tactical benefits and opportunities for knowledge sharing. These include textiles with anti-bacterial properties, fatigue monitoring, chemical hazard sensing, electrochemical sensing, and colour sensing. These sensor systems detect harmful chemicals in real-time, quickly and accurately, significantly reducing the risk of harm to soldiers. This operational and safety benefit would also reduce the need for extra equipment, increasing soldier mobility. In collaboration with stakeholders including 'industry, research-and-technology organisations, [and] universities', the EDA will create opportunities for knowledge sharing, resource management and the transition toward a circular economy (European Defence Agency, n.d.-e).

The three IF CEED projects; circular data, additive manufacturing and smart modular protective highlight a leap toward embracing a circular economy in the defence sector. These innovations promote sustainability while also increasing operational efficiency, reducing costs, knowledge sharing and fostering collaborations between defence and civil sectors.

Conclusion

While Circular economy initiatives require significant investments, this value will likely result in reduced costs and operational benefits. As this challenge requires close collaboration between the defence and civil sectors, it offers the opportunity for enhanced interoperability between them. Embracing technology will give European forces a unique competitiveness, which is necessary to adapt and guarantee security in a complex security landscape. In the future, the EDA must turn its focus from testing to implementation on a larger scale. Standardisation in innovative technology such as mobile additive manufacturing, is another essential requirement to avoid future interoperability challenges amongst European armed forces. However, innovation must be supported by research and appropriate legislation regarding dual-use technologies such as additive manufacturing. The UNFCCC must also place greater emphasis on the role of defence forces and conflict in global emissions. In the framework of those protocols, the armed forces need to show responsibility in reporting and mitigating their emissions by balancing innovation and circular economies with operational readiness. Creating a circular economy will see positive flow-oneffects for European defence across operations and spending while also reflecting the necessity for investment in innovation.

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