Re-imagining Design Processes for Circularity in Electric Motors

Call for Participation

Introduction

The Digital Design Network Plus (D2N+) invites researchers and practitioners from across the UK to participate in Challenge Case Study 2, a collaborative initiative focused on advancing digital engineering design. D2N+ is a 3-year EPSRC-funded programme that brings together academia, industry, and research organisations to explore how digital design technologies can transform the way complex engineering systems are conceived, developed, and delivered. The network aims to demonstrate how engineering design can be improved to deliver solutions that are Faster, Better, and With Less, supporting the UK's transition to Net Zero. Challenge Case Study 2 builds on this vision by addressing a key gap in current engineering practice: the need to design products that are not only efficient to manufacture but also sustainable across their entire lifecycle.

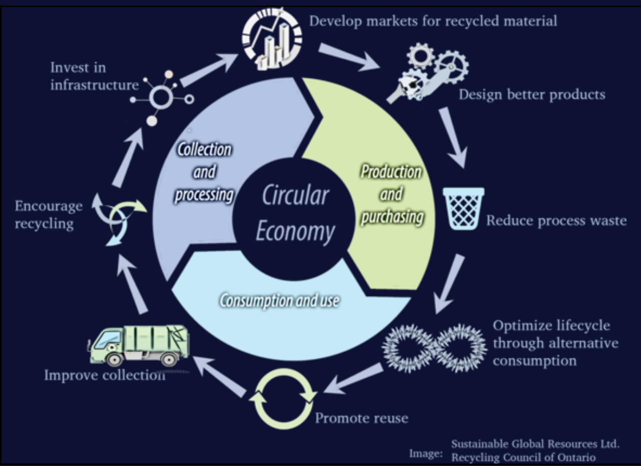
Context & Motivation

Most products today are designed using **Design for Manufacturing and Assembly (DfMA)** principles to optimise production speed and reliability while minimising cost. While highly effective for manufacturing efficiency, this approach often overlooks what happens beyond production, particularly during maintenance, repair, and end-of-life (EoL). As a result, many products are not designed to be taken apart. At the maintenance, repair, and EoL stages, products are often difficult to disassemble without specialised tools, expertise, and processes. This significantly limits the ability to repair, reuse, remanufacture, and recover high-value materials, including magnets, rare earth elements, and electronic components. For instance, the modern smartphone is highly optimised for assembly yet difficult to open, repair, or recycle without specialist intervention. This design paradigm leads to several systemic challenges across the product lifecycle:

- **Limited repairability**: Products are difficult to maintain or repair, reducing lifespan and limiting user empowerment.
- **High cost and complexity of servicing**: Disassembly often requires specialised knowledge, tools, and equipment, increasing costs for both consumers and service providers, and driving additional training and investment.
- **Inefficient end-of-life processing**: Materials are difficult to separate effectively, resulting in reduced recycling efficiency and lower overall sustainability, and loss of high-value and critical materials (e.g. rare earth elements), constraining circularity and resource security.

Design for Circularity and Right to Repair

Circularity is the design and management of products and systems to ensure that materials, components, and value are retained for as long as possible through reuse, repair, remanufacture, and recycling. Achieving this requires decisions made at the concept design stage, rather than being addressed at the end of life.



With increasing emphasis on the UK's Circular Economy Strategy, Right-to-Repair initiatives, and Net Zero targets, there is a clear need to rethink this approach. Future engineering design must embed circularity at the concept stage, supported by digital design methods that enable lifecycle-aware, data-driven decision-making. This shift is increasingly driven by national priorities and regulatory direction within the UK, including:

- The legal commitment to achieve Net Zero greenhouse gas emissions by 2050
- The phase-out of petrol and diesel vehicles, accelerating electrification
- The UK's emerging Circular Economy Strategy
- Growing Right-to-Repair policy direction, promoting product longevity and repair ecosystems
- The introduction of Digital Product Passports (DPP) for lifecycle transparency
- The Digital Sustainability Strategy (Defra 2025–2030)
- The UK's Industrial and Advanced Manufacturing Strategy

From DfMA to DfMAD

Current engineering practice is largely based on Design for Manufacturing and Assembly (DfMA) as an approach that optimises products for efficient production by:

- Reducing production cost and complexity
- Minimising the number of parts and assembly steps
- Simplifying manufacturing processes
- Standardising components
- Improving production speed and reliability

While highly effective for manufacturing, DfMA does not adequately address what happens after the product is built. To meet emerging circularity and sustainability requirements, design should evolve toward Design for Manufacturing, Assembly and Disassembly (DfMAD). DfMAD extends traditional design principles by considering the entire product lifecycle, enabling:

- Non-destructive disassembly
- Accessible repair and maintenance
- Component reuse and upgrade
- Efficient material separation and recycling
- Integration of lifecycle and circularity considerations at the concept stage

The Design Gap

Despite increasing policy and industrial pressure, most products today are still designed primarily for assembly, not disassembly. This creates a fundamental gap between:

- How products are designed today, and
- What is required for a circular, Net Zero future

Closing this gap requires rethinking the design process itself and leveraging digital design technologies to enable lifecycle-aware engineering decisions.

Circularity is not an end-of-life problem; it is a design problem.

Use Case - Electric Motors in Electric Vehicles

The question is no longer how we build EV motors but how we design them to come apart, recover value, and enable the next generation of sustainable technology.

The transition to electric mobility in the UK is no longer a future ambition; it is already underway. As of 2025, there are approximately 1.8 million electric vehicles (EVs) on UK roads, with projections indicating this will rise to over 11 million by 2035, driven by the UK Government's mandate for 80% of new vehicle sales to be zero-emission. This rapid adoption is creating a growing stock of high-value engineered components that will, within the next decade, begin to reach maintenance, remanufacture, and EoL stages at scale. At the centre of this challenge are electric motors. Electric Motors as Critical Resource Systems are not just mechanical devices; they are complex, high-value material systems containing Critical Raw Materials (CRMs) essential for modern electrification technologies, including:

Material	Significance	Circularity Challenge
Rare Earth Magnets	Contains Neodymium (Nd) and Dysprosium (Dy), essential for high efficiency and torque	Difficult to extract without damaging or contaminating the material
High-Purity Copper	Used in dense stator windings for electrical performance	Conventional recycling mixes copper with steel, reducing material quality
Electrical Steel	Specialised laminations for magnetic flux performance	Often bonded with resins, making clean separation difficult

An Emerging System-Level Challenge

The first generation of EVs (circa 2010–2015) is now approaching end-of-life. However:

- These motors were designed using DfMA principles, optimised for performance and compact assembly
- Current recycling approaches are often destructive (e.g. shredding), resulting in loss of material value
- There is no scalable, design-led approach for remanufacturing or high-value material recovery

Without intervention, for future products we risk:

- Millions of tonnes of valuable materials being lost to low-grade recycling or landfill
- Exporting end-of-life vehicles rather than retaining material value domestically
- Vulnerable and import-dependent supply of the critical materials needed for future EVs and green technologies remains

This Challenge Case Study invites participants to use EV motors as a representative system ("canvas") to:

- Re-imagine how engineering systems can be designed for circularity from the outset
- Embed Design for Disassembly (DfMAD) into the design process
- Demonstrate how digital design approaches can enable:
    - Faster design exploration and iteration
    - Better lifecycle performance and sustainability
    - With Less material, energy, and lifecycle cost

The focus is not on optimising motor physics, but on transforming the design process itself to enable circular, lifecycle-aware socio-technical engineering systems.

Challenge 2 – Improving Digital Design for Circularity and Sustainability

This challenge invites participants to reimagine the EV motor design process. The team must demonstrate how an integrated digital design approach can enable products to be designed Faster, Better, and With Less, while embedding circularity principles such as Design for Disassembly (DfMAD) from the earliest stages of engineering design.

This challenge focuses on how digital design can transform engineering workflows to deliver:

Faster	Better	with Less
- Rapid exploration of design alternatives using generative design and AI - Automated evaluation of disassembly and lifecycle scenarios - Reduced iteration time through integrated simulation and data workflows	- Rapid exploration of design alternatives using generative design and AI - Automated evaluation of disassembly and lifecycle scenarios - Reduced iteration time through integrated simulation and data workflows	- Reduced material usage and waste through optimised design architectures - Lower lifecycle cost and energy consumption - Simplified products with fewer parts, standardised components, and easier disassembly

Scope of the Challenge

The scope of this challenge is intentionally broad and interdisciplinary. Participants may address any aspect of the design process, including:

- Digital tools, methods, or algorithms
- Design workflows and data integration
- System-level or lifecycle modelling
- Circular design strategies and frameworks

The Role of Digital Design

Digital design technologies, including simulation, digital twins, AI/ML, generative design, and Digital Product Passports, provide the capability to:

- Integrate data across the product lifecycle
- Enable new forms of decision-making at the design stage
- Connect previously fragmented tools into coherent, lifecycle-aware design workflows

What We Are Looking For

We welcome innovative proposals that demonstrate how improved digital design processes will enable DfMAD that is Faster, Better and with less. Example approaches may include:

- Digital twins and lifecycle simulation
- Generative design and optimisation
- AI and machine learning for design exploration
- Data integration and transformation across tools
- Digital Product Passports and traceability frameworks
- Disassembly planning and circularity assessment tools
- Human-centred design for maintenance and repair
- Behavioural and decision-support approaches to enable lifecycle-aware design
- Creative technologies (CreaTech), including AR/VR and immersive environments

We strongly encourage interdisciplinary collaboration, including contributions that integrate technical, human, and systemic perspectives. Participants are encouraged to propose novel ideas, methods, or frameworks. Participants may base their work on existing designs, publicly available data, or relevant published research, where appropriate. In addition, the Challenge Case Study 2 team can provide an IP-free reference design of an EV motor to support participants. The use of such resources is optional and intended to enable broad participation while ensuring a consistent basis for comparison where needed.

Potential Expected Outcomes: Integrated Digital Design

A core requirement of this challenge is the development of an integrated digital design approach.

- A digital demonstrator or prototype illustrating the improved integrated workflow design process for electric motors
- Evidence of measurable improvement in at least one of the three criteria (Faster, Better, with Less) for the improved circular designs of electric motors
- A framework or workflow for applying DfMAD principles using digital tools for the improved circular designs of electric motors
- A digital tool that evaluates the circularity of product design (e.g. score out of 100 on disassembly)
- A digital tool that suggests design improvements to improve the circularity design of products.

Competition Details

Funding Details

The call is open to all UK academics whose institutions are eligible to receive EPSRC funding. Funding allocation criteria will prioritise Early-Career Researchers (ECR) with high-quality ideas from a variety of disciplines. Approximately 15 awards are available.

Conditions of funding include:

- Up to £14,000 at 80% FEC (funding = £11,200) to cover academic staff time, consumables and travel.
- Funding for Research Assistant time, PhD students, or equipment is not available.
- Budgets should include costs of attending a two-day network workshop to be held in Sheffield, on 1st and 2nd December 2026.

Participants will be expected to:

- Work in a multi-disciplinary team to propose an integrated design process for improving circularity in Electric Motors (Temas will be formed by the Network Team).
- Attend D2N+ online meetings with Challenge 2 Co-leads while the Case Study is active to report on progress
- Attend the D2N+ Workshop 3. The Workshop 3 event will take place at the University of Sheffield and the AMRC in Sheffield on the 1st and 2nd of December 2026.
- Present your team's solution at Workshop 3 (Teams are allocated a maximum of 1 hour to present their results at Workshop 3)
- Report on the solutions and findings of Challenge 2 that will be included in the Digital Design Network, a video of your work and any draft publication.
- A short video of your solutions to be published through the Digital Design Network Plus and prepared for Workshop 3

How to apply

Applicants are invited to apply via the link below, including the following:

- Curriculum Vitae (maximum 2 pages)
- Relevant publications or outputs (maximum 1 page)
- Institutional letter of support (from Head of Department or equivalent)

Application Link: Digital Design Network+ Challenge Case Study 2 – Fill in form

Applicants are required to respond to the following questions (maximum 250 words each):

1. **Experience in Digital Design**
   Please demonstrate, with relevant examples, your experience and interest in digital technologies and/or digital design.
2. **Proposed Contribution**
   Please describe what you would contribute to the Challenge Case Study and how your approach would support the development of an integrated digital design workflow.
3. **Collaboration and Stakeholder Engagement**
   Please outline your ability and willingness to work within a multidisciplinary team and to engage with multiple stakeholder groups (e.g., RTOs, software vendors, end-users, and academic communities).
4. **Digital Tools and Methods**
   Please indicate any **digital tools, methods, or approaches** you intend to use, and how these could support or enable improved circularity and design for disassembly in electric motors.

Assessment of Applications

Applications will be reviewed by the Case Study 2 leadership team. Applications will be assessed based on:

- Alignment with career stage eligibility
- Demonstrated experience and interest in digital design and technologies
- Clarity and strength of the proposed contribution to the challenge
- Potential to contribute to an integrated, collaborative solution
- Feasibility and appropriateness of the proposed approach within the scope of the challenge

Successful applicants will be allocated to multidisciplinary teams, designed to ensure complementary expertise and the development of cohesive, integrated solutions.

Challenge 2 Timeline

Activity	Date
Call Launch	23rd of March 2026
Webinar	30th of March 2026
Closing Date for Applicants	21st of April 2026
Successful Applications Announcement	5th of May 2026
Challenge Period	From 1st June to 30th November 2026
Workshop	1st and 2nd of December 2026

Questions and Support

If you have any questions about the above, please feel free to contact us

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