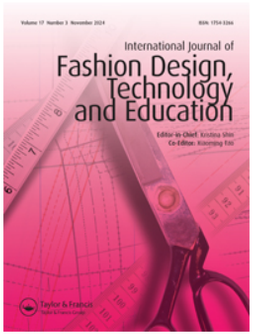

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Future fashion factory: developing an ecosystem to support sustainable change

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ABSTRACT

This paper explores the development of an ecosystem to facilitate sustainable change through one of the initiatives established by the 5-year Future Fashion Factory programme, led by the University of Leeds in the UK. This was a £6.1 million Research and Development, industrial-academic partnership that investigated how the development of new technology could enhance the design and creation of fashion and textile products. This study describes one of the Future Fashion Factory initiatives, developed to identify challenge areas in the fashion and textile sector. This comprised of the competitive Responsive Research & Development funding calls that enabled the Future Fashion Factory to allocate 55 awards to industrial members, with projects aligned with the programme's Core Research Themes. The varied awards successfully aligned relationships between industry and academia and facilitated new thinking that developed an ecosystem to support sustainable change within the UK fashion and textiles sector.

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KEYWORDS
Future Fashion Factory; creative industries; innovation challenge; ecosystem; sustainable

Introduction and background

The Future Fashion Factory (FFF) programme, led by the University of Leeds and including academic partners: the University of Huddersfield and the Royal College of Art was an Arts and Humanities Research Council (AHRC) funded 5-year initiative, which was part of a wider programme of Creative Industries intervention. At a prominent level, FFF sought to develop an ecosystem to support sustainable change for the fashion and textile sector, exploring and developing new digital and advanced textile technologies to boost the design of high-value creative products within the UK economy. FFF defines an ecosystem in relation to Leydesdorff's proposal, which was a triple helix-based multi-factor network that links educational, industrial and government/policy to form a cohesive infrastructure that will maximise impact (Leydesdorff, 1995). This approach was adopted by FFF mechanisms and aligned with five Core Research Themes (CRTs), the development of which was informed by industry consultation and government initiatives. This ensured the alignment of FFF delivery with challenges identified by the UK fashion and textile sector as critical to their business operations. Industry consultation was on-going, via focused working groups and one-to-one interviews, during the funding development process. These CRTs underpinned all intervention mechanisms developed by the FFF programme and are sub-divided into two thematic areas (Table 1).

The investigation in this paper focusses on describing and unpacking the integrated programme of Responsive R&D funding that enabled FFF to allocate funding awards to industrial members with projects aligned with the FFF CRTs. Each industry-led award included support from a senior academic lead, and in the majority of cases, an early career researcher (ECR) from one of the three FFF Higher Education Institutes (HEI) partners. Industrial members of the FFF emerging ecosystem included: Burberry PLC, Yorkshire Textiles, UK Fashion & Textile Association (UKFT) and the British Fashion Council (BFC) as well as the regional public authorities: Leeds City Council and Leeds City Region LEP (now West Yorkshire Combined Authorities (WYCA)). The Responsive R&D awards represented an investment of £1.6 million (from the original £6.1 million funding) that leveraged co-investment of £2.7 million from a combination of industry and HEI sources. The FFF network also provided high-profile events to support the development of the Responsive R&D projects, brokering wider ecosystem connectivity and demonstrating successful academic-industry engagement mechanisms.

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Table 1. Industry-identified Core Research Theme challenge areas which underpinned all FFF delivery.

Core Research Theme (CRT)	Thematic Alignment
Circular Economy / Sustainability	Theme 1: Digitally Connected and Sustainable Processes
Late Stage Customisation	
Data-Driven Design / Use of AI	Theme 2: Digital Communication and Data Analytics
Aesthetic Digital Communication	
Skills and Education	

The authors took on two differing roles in the overall FFF Responsive R&D projects. Almond was Co-Investigator for the entire programme, with leadership in one of the CRTs – Skills and Education, and the academic delivery partner for the two Responsive R&D projects discussed within this paper. Rainton was the overall Programme Manager for FFF, joining the programme in January 2019. They developed and operationalised the Responsive R&D process, including iterative changes to the process in response to stakeholder feedback. They also managed the Investment Committee process (but crucially without having a say in funding outcomes, which avoided potential conflict of interest and biased opinion); then supported and monitored project delivery and reporting. The authors' contributions to the Responsive R&D funding mechanism and the Responsive R&D projects consisted of a hands-on approach, which allowed critical reflection on all aspects of their development. Both authors were strategically positioned to harness their expertise in a general overview of the CRTs as well as advising on the development and progression of the Responsive R&D grants awarded to industrial members.

The first section of the paper – Identifying the Opportunity – describes UK and global initiatives in the creative industries that include partners from industry, academia, and government organisations and how these collaborative ecosystems can move the fashion and textile sector forward. This sets a context for the overall rationale for the development of the FFF programme and how the Responsive R&D awards were allocated and supported the development of the ecosystem. The methodology describes the reflective practice-based approach and the subsequent analysis of findings from the projects awarded funding. The results section explores the building blocks for the formation of FFF to set a context for the focus of this paper and the subsequent ecosystem. It also details the development of the Responsive R&D projects and describes how FFF allocated the industry-led innovation focused grants to members of the ecosystem through an open application process. This paper focuses on an in-depth description of two of these grants as examples. The conclusion identifies how the grants, and the FFF programme, have been both incentive and facilitator for new thinking and practice in the UK fashion and textile sector. It discusses some of the challenges encountered during delivery and identifies how the outcomes can inspire greater opportunities for global innovation through the development of comparable sustainable creative eco-systems. The FFF contribution is positioned in relation to the wider Creative Industry Cluster Programme (CICP) and associated Key Performance Indicator contributions.

In short, the paper aims to contextualise the CRTs that represented challenge areas, identified by the UK fashion and textile sector, as critical to their business operations, and to unpack the integrated programme of Responsive R&D funding that enabled FFF to allocate the Responsive R&D grants with aligned aims. This is discussed through the detailed analysis of the two projects as case studies, which were awarded funding. Finally, the paper explores how the FFF Responsive R&D grants supported the development of the ecosystem to facilitate sustainable change and established new digital and advanced textile technologies to boost the design of high-value creative products in the UK fashion and textile industry.

Identifying the opportunity

The creative economy can be defined as commercial endeavors, which depend on creativity to outline their economic significance (Conti, 2023; Denning, 2014; Howkins, 2013; Jun, 2020; Kong & O'Connor, 2009). To inform an understanding of policy and investments into the creative industries and their economy both in the UK and globally a number of publications were consulted (Bazalgette, 2017; CICP, 2020; Frontier_Economics, 2022; GOV.UK, 2017, 2023; UKFT, 2022; UKRI, 2023b; UNESCO, 2013). This revealed and emphasised how the creative economy is a fast-developing global asset that supports intense growth in financial gain, employment and earnings. The UNESCO Report on creative economy emphasised, "When the creative sector becomes part of an overall development and growth strategy, it can contribute to the revitalisation of the national economy where hybrid and dynamic economic and cultural exchanges occur and innovation is nurtured" (UNESCO, 2013, n.pag). Sir Peter Bazalgette, who since 2021 has been Co-Chair of the Creative Industries Council in the UK, produced an independent review of the creative industries in 2017 which considered what the future of the UK economy would be like in 20 years' time. This followed an independent

review of the creative industries for the UK Government's Department for Digital Culture, Media and Sport (DCMS) into the potential of the creative sector to support the UK economy and become a growth sector for the future. Bazalgette states, "This report recommends ways of maximising the potential of this crucial sector. I am proposing simple ideas which I'd like to see become part of the government's developing Industrial Strategy" (2017, n. pag). His ideas included: harnessing the creative activities and strengths of all regions within the UK, crucially extending beyond London; a continued programme of nurturing creative strength through a considered education and skills system and enhancing the development of digital technologies to maintain strong innovation such as 3D printing, 5G and Virtual and Augmented Reality (Bazalgette, 2017).

The Bazalgette Report concluded that the Industrial Strategy and accompanying sector deals were perfectly positioned to support growth within the creative industries (GOV.UK, 2023). The CICP generated a network of nine Creative Research and Development Partnerships (CRDPs) that were subsequently established to epitomise the aspiration of these sector ideals, being based on existing geographic clusters of academic and industrial excellence deemed to have high growth potential. Of the nine CRDPs, two were fashion and textiles focused whilst the others spanned a range of other creative industry activity (UKRI, 2023a). These CRDPs were nationally distributed across the UK following Bazalgette's recommendation for a bottom-up approach, allowing in most of the cases regional focus to drive innovation opportunities. The resultant network (or ecosystem) was established because of the £80 million investment by the Industrial Strategy Challenge Fund (ISCF), awarded through the AHRC. The aim of this fund was to, "Create jobs and drive the creation of companies, products and experiences that can be marketed around the world, significantly contributing to UK economic growth both regionally and nationally" (UKRI, 2023a, n.pag). By the final year of the original delivery period, the CICP has out-performed original targets with the initial investment worth £252 million. Collectively the CICP has funded over 700 R&D projects, created or safeguarded over 4,000 jobs, trained over 3,500 industry professionals and academics, supported 227 new spin outs and start-ups, and created 566 new products and services (AHRC, 2023).

Case studies from the FFF Responsive R&D mechanism, the focus of this research, have been documented and disseminated in a variety of project engagement communications and publications by academics involved in the individual projects (Almond, 2020, 2022; AWH, 2020; Ellams, 2022; FFF, 2019, 2021; Hewitt & Goswami, 2023; Iszoro, Almond, & Alcoceba, 2021; Numerion, 2021; Teal et al., 2022). Within the scope of this paper, it is not possible to detail all projects, instead we explore two of these projects in more depth; AW Hainsworth & Sons Ltd (Call 1) and Numerion Software Ltd (Call 3); presenting them as case studies to reflect the range of methodology utilised and outcomes generated across the programme of Responsive R&D interventions.

Methodology

The paper adopted a reflective practice methodology. This approach allows the researcher to reflect on an activity or project to critically analyse the accomplishments involved within it and absorb and learn from them. Through both reflexive and contemplative analysis, the results of the practice permit progressive insight related to its impact. Consideration of all the activities as opposed to involvement in them is the key rationale for this method (Colwell, 2024; Denzin, 2006; George, 2022; Nelson, 2013; Pathak & Kalra, 2013; Scaife, 2010; Schon, 1983). The method was also deemed appropriate because (as emphasised in the introduction) both authors were actively involved in the running of FFF, as Co-Investigator and Programme Manager, and in a strong position to reflect on the research activities involved in all Responsive R&D endeavours.

Initially, reflective practice was adopted to consider the completed Responsive R&D projects in relation to the research aims of this paper. The objective was to identify what new knowledge was created through the emerging ecosystem and how this could successfully support new ideas and products for the companies involved. The methods used to collect data throughout the projects were varied and often employed a mixed methodology that combined both qualitative and quantitative elements. This approach was characterised by George, who defined how mixed methods enable " … a more complete picture than a standalone quantitative or qualitative study, as it integrates benefits of both methods" (George, 2022, p. 1). Utilising this method enriched the process of reflection as the researchers could consider their past activities, observations and material from other colleagues involved in the projects. The two projects are described in the *Responsive R&D: Example Case Studies* section of the paper. The data collection techniques for these projects are also described together with an analysis of the how the results of each project impacted on the emerging ecosystem.

Content analysis was employed to examine the data gathered from the reflective practice. This form of scrutiny is used to identify themes and concepts. In the two case studies, this included: text, interviews, images, three-dimensional objects, audio recordings, film, etc. Within this research, the approach facilitated a micro understanding of how the ecosystem evolved through the impact of the two case studies and their contribution to new thinking and practice within the UK fashion and textile sector. On a larger scale, this was contextualised in relation to the impact of the further projects awarded R&D funding and the impact of the system on sustainable change. On completing the analysis, triangulation of the results took place through consultation with six fashion industry professionals who had not been involved in the research process (Flick, 2004; Vaughan, 1992). Each was asked to consider how the ecosystem, developed through the Responsive R&D grants, contributed to new thinking and practice within the UK fashion and textile sector as well as the impact of this system on sustainable change. These objective observations of the results, from different viewpoints and experiences, resulted in a reliable data set that contributes to knowledge around creative industries ecosystem learning.

Background to future fashion factory and the responsive R&D funding

In line with established thinking around issues and ideas within the sector, established through co-development of CRTs, FFF was set up as a fashion & textile focused, technology cluster. It built on a range of existing relationships between regional centres of academic expertise in Yorkshire (Universities of Leeds and Huddersfield) and London (Royal College of Art) and the world-renowned Yorkshire textile mills (Cookson, 1997; Fowler, 2010; Gregory, 1982). The combination of world-leading academic expertise, led by the University of Leeds, and the industrial partners representing the historic heartland of textile production within Yorkshire in the UK, created a compelling narrative for cluster recognition and development (FFF, 2018). At the heart of the cluster was the strong drive to develop mechanisms to support industry-facing co-development of impactful innovative practice. This included leveraging the following:

- Yorkshire-based regional cluster of significant academic and industrial members.
- Lead partner, University of Leeds with over 140 years textile experience delivering academic programmes and projects with the industry.
- Good academic connectivity through staff networks in industry and education.
- Great links to local government and local enterprise partnerships.
- Strategic alignment with local, regional, and national priorities.

The development of the ecosystem to support sustainable change within the fashion and textile industry therefore made sense both strategically and creatively within the UK economy and was also considered in relation to the size and formation of the industry (FFF, 2018, p. 2):

- There are over 4,000 fashion and textile businesses in the UK with 1,800 new companies registered between 2017 and 19.
- Over 100,000 people work in fashion and textile businesses including 40,000 in textile manufacturing, generating £8 billion in UK revenues.
- Yorkshire's mills supply global luxury brands, some exporting up to 90% of total production.
- Burberry's UK vertical manufacturing operations are located in the Leeds City Region.

FFF developed a nationally distributed ecosystem across the UK whilst retaining regional geographic connectivity to Yorkshire & The Humber within the Responsive R&D delivery mechanism.

The process

The process for developing the concept behind the FFF programme was centered on an industry-facing listening approach (FFF, 2022b). The views and ambitions of the UK fashion and textile industry were paramount to shaping the development of the ecosystem to initiate change that was sustainable, creative and pioneering. This involved adapting to and building in industrial ideas for increased connectivity that were both flexible and responsive and supporting end-to-end innovation across design, manufacture, and retail. The outcome was a £6.1 million programme of activity supported through the Industry Strategy Challenge Fund (UKRI, 2017) award via AHRC, crucially programme co-development was successful in leveraging an additional £3 million commitment pledged by industry, University of Leeds, University of Huddersfield and the Royal College of Art.

Structure

The FFF organisational structure, delivery mechanisms and outcomes were co-developed with an initial core of

ten key industrial contacts & sectoral membership bodies. Crafted in such a way as to be able to demonstrate impact for the sector, the management structure comprised a strategic steering group and a more operationally focused programme management group, providing a mechanism to update industry members and cross-organisational academic partners on progress with CRT activity, and a core management team. Each academic partner had a nominated lead investigator who had a place on the steering group. Management groups met quarterly aligned with funder reporting requirements.

Initial planning for programme delivery identified seven different ways of working which would achieve the aims and objectives of the programme (Figure 1). These covered the identified five CRTs (detailed in Table 1), three Responsive R&D mechanisms (Proof of Market, Proof of Concept, and Innovation Challenge projects) which themselves acted as sample prototyping and test bedding of new technologies, alongside skills-focused activities (Internships & Placements, Training and Incubation).

As programme thinking developed this became embedded in FFF in a three-layered structure of CRT activity, which underpinned the responsive R&D investment process and informed strategic brokerage, ecosystem events and dissemination activity (Figure 2).

The Responsive R&D programme was designed as a series of open industry-led calls with levels of funding allocated to projects depending on how close to market the proposed innovation was at project start. FFF activity was predicated on achieving commercial impact, so market readiness was a key consideration for the independent Investment Committee, which awarded funding. Intervention levels (i.e. the proportion of grant award to company match funding) were based on a combination of accepted UK standard intervention rates to company size, with a reduction for Proof of Market interventions which recognised the early-stage nature of these proposals. Responsive R&D funding awards started at up to £10k for a Proof of Market project, working up to a maximum of £100k for an Innovation Challenge Project award (Table 2).

All projects were structured with an element of skills development in mind with both senior academics and early career researchers (ECRs) being directly connected with industrial funding applicants throughout project delivery. This approach broke down barriers to industrial and academic engagement and fostered an open and exploratory way of working across the emerging ecosystem. Project development was supported by brokerage activity within the FFF delivery team and

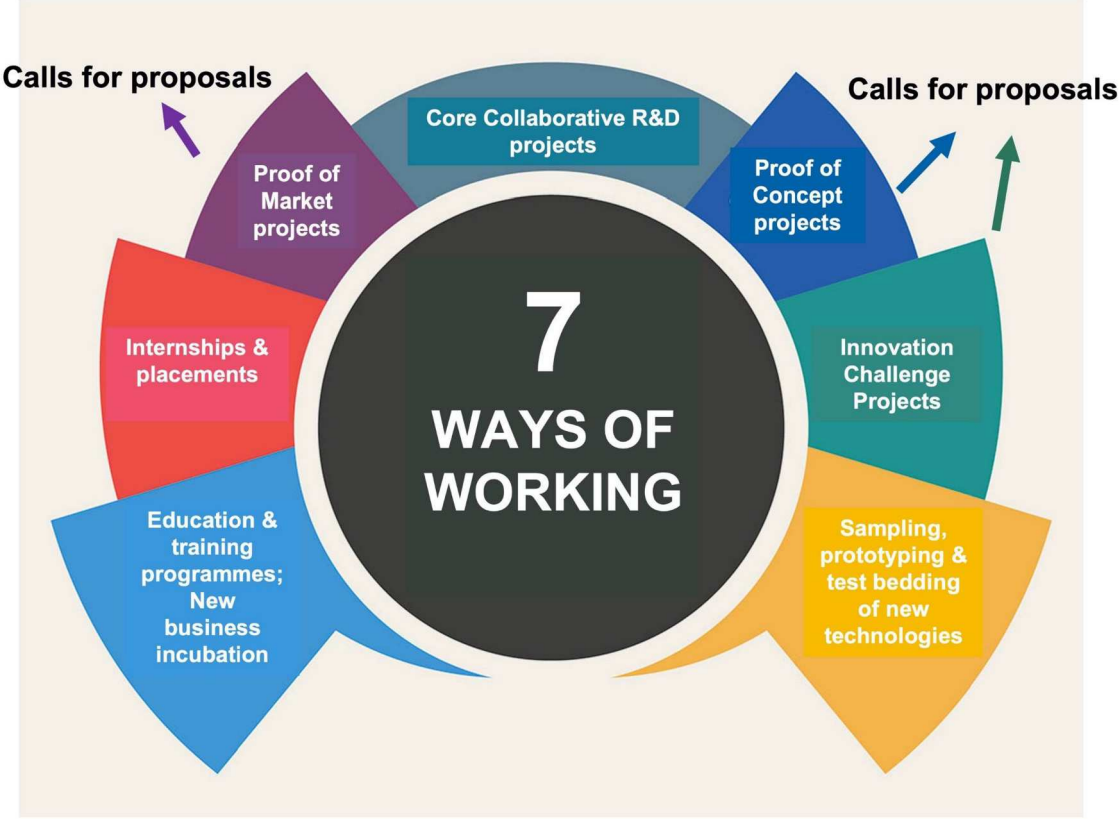

Figure 1. Diagram showing seven different ways of working which would achieve the aims and objectives of the FFF programme.

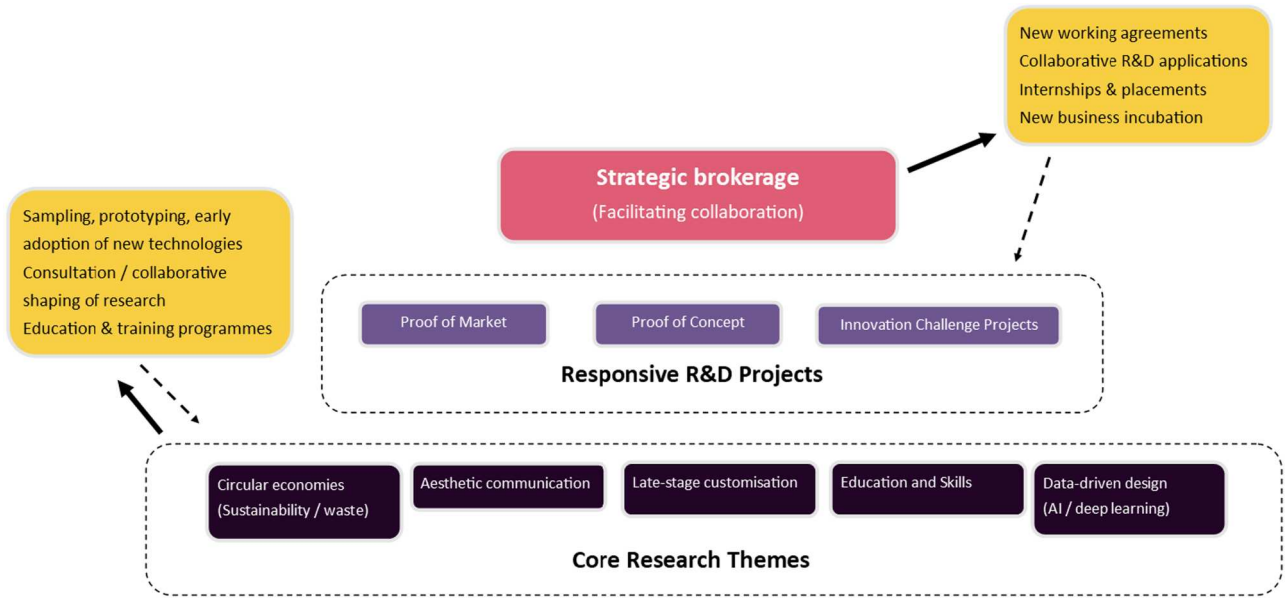

Figure 2. Three layers of FFF operation, under-pinned by five Core Research Themes co-developed with industry.

Table 2. Overview of FFF Responsive R&D structure showing the three levels of funding available.

Funding Stream	Total Project Value	Maximum Grant Value	Purpose	Funding Breakdown
Proof of Market (PoM)	Up to £10k	£9k	To evaluate a market opportunity; identify existing IP/ conduct freedom to operate searches; explore further funding options; carry out small-scale R&D activity.	10% minimum match-funding requirement 90% Intervention rate
Proof of Concept (PoC)	Up to £50k	£37.5k	To carry out interventions that progress proven methods and knowledge into validated technologies for a defined application.	25% minimum match-funding requirement Up to 75% Intervention rate *Varies depending on company size & project*
Innovation Challenge Project (ICP)	Up to £100k	£60k	Funding for innovations in partnership with industry to demonstrate and begin to scale up new technologies in a commercial setting. Such projects should be near to market (TRL 7-8, *see table on page 6*)	40% minimum match-funding requirement Up to 60% Intervention rate *Varies depending on company size & project*

resulting awards were split between the three categories; 9 Proof of Market, 32 Proof of Concept and 14 Innovation Challenge Projects.

In addition to fundamental, innovative exploration of sectoral challenges and R&D directed at industrial problem-solving, FFF used other activities to ensure ecosystem cohesion and effective dissemination of programme outcomes. A series of physical and online speaker events, seminars, creative labs and showcase events was delivered during the programme (Figure 3). The types of engagement included a formal membership system for industrial partners, which provided a mechanism to ensure that comments and requests were captured as a focus for the development of new activity.

The responsive R&D grants

Following the integrated series of open calls and investment committee appraisal that comprised the Responsive R&D mechanism, 55 innovation projects were awarded funding. This part of the FFF programme focused on industry-led applications for short-term industrial challenges designed to impact positively on their business operations. In line with initial learning at the inception of the FFF programme, all of these projects were aligned with one or more of the CRT and, each project was devised to align an industry investigator with an academic from one of the three educational institutes (Universities of Leeds and Huddersfield, and Royal College of Art) whose research interests and expertise matched the aims of the industrial challenge. Successful projects covered a wide range of industrial areas such as: development of sustainable materials and processes; design of mechanisms to support industry engagement; development of digital tools to aid both designers and manufacturers; data-driven design learning to inform product decisions and optimise production processes. An overview of all the completed Responsive R&D projects is available on the FFF-funded projects and news pages (FFF, 2022a, 2023).

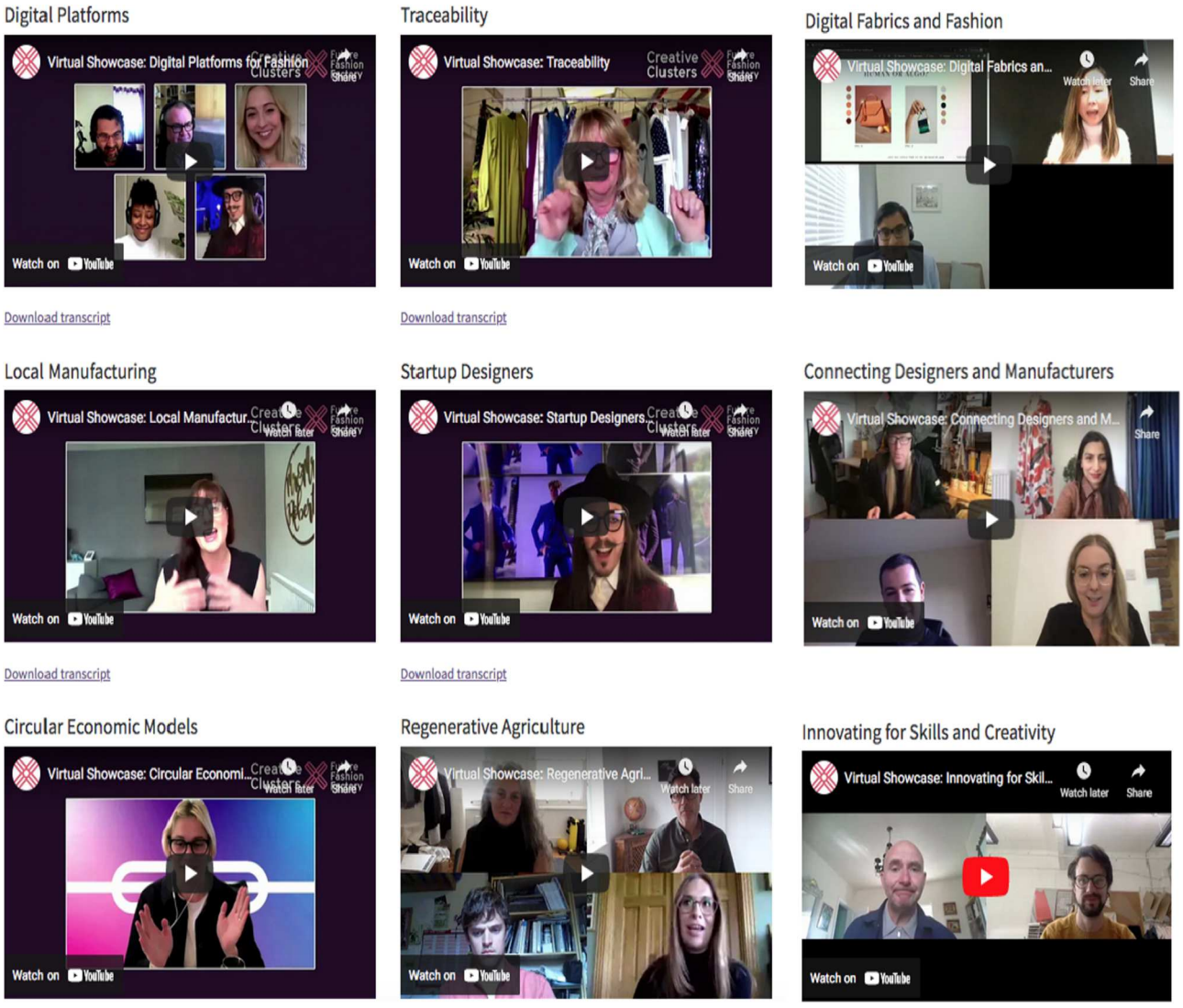

Figure 3. Overview of the types of engagement events FFF used to sustain ecosystem cohesion.

Examples of projects undertaken were diverse, with a range of needs identified and included topics such as: developing online fashion technologies; the correlation of wool fibres and dyeing; life cycle of British Wool facemasks; R&D activities within fashion design and manufacture; virtual reality as a means of creation and communication, etc. A number of projects were concerned with issues identified by the bra making company Brarista Ltd. They wished to investigate if digital technologies such as Artificial Intelligence (AI) could facilitate bra fitting to reduce fabric waste, and development time. British Wool, an organisation who promote British fleece wool, wished to investigate the optimisation of fibre properties through yarn design to extend the durability of the fabric. Assyst Bullmer Ltd, investigated design-led adoption of digital technologies for small-scale manufacture. Numerion Ltd, investigated market introduction of Virtual 3D draping as a service. Fashion organisations and sectoral bodies who have initiated new thinking and sustainable change in fashion and textiles were also consulted such as: Burberry PLC, Yorkshire Textiles, UK Fashion & Textile Association (UKFT) and the British Fashion Council (BFC) as well as the regional public authorities: Leeds City Council and WYCA. The following section describes in more detail two of the projects, to demonstrate further diversity of experimentation and innovation as well as detailing how participants in each project contributed to the development of the ecosystem.

Responsive R&D: case studies

Call 1: A.W. Hainsworth & Yorkshire textiles – proof of concept

In the first funding Call, a project was funded between the heritage woolen mill, A.W. Hainsworth & Sons

Ltd (AWH, 2024) based in Leeds, West Yorkshire, and Yorkshire Textiles Ltd, an organisation co-founded by FFF's Co-Director, Suzy Shepherd (Shepherd, 2024). This was supported by an academic lead, with significant experience in the use of fashion and textile archives as inspiration to inform contemporary design (Almond, 2020).

The project investigated the digitising of early jacquard designs from punch-cards held in the collection at Leeds Industrial Museum (LCC, 2023), to produce a new heritage fabric for manufacture on a modern jacquard loom. At project inception, the company clearly set out the challenge to be addressed,

> Fashion designers want to stamp their own identity on their collection, but with smaller ranges it is often difficult to meet the minimum order quantities for most fabric suppliers … ' 'We've been offering bespoke colourways for several years, but we needed to go a step further to support these fashion startups. At Hainsworth we started thinking about a service where we could offer short runs of bespoke fabric designs. (FFF, 2020, n.pag)

The project involved a qualitative approach, utilising practice-based research within the activities. This included creative practice through the innovation of a new way of working for the company. A.W. Hainsworth ultimately used the project to trial a new designer-led short production run service for bespoke fabrics. As a result of successful project delivery, the company has since gone on to feature this new bespoke short-run service in its 2020 Sustainability Strategy (AWH, 2020).

Alongside technical delivery, and in support of the Skills and Education CRT, the project was incorporated into an undergraduate project for the second year of the BA (Hons) Fashion Design course at University of Leeds, to stimulate student innovation and inspire learning activities as well as include students in the developing ecosystem. The students visited the Hainsworth factory to observe the fabric being woven on the loom, gaining a more in-depth understanding of how heritage products such as fabric and garments could be reworked and recreated in an original approach for a contemporary customer. The student brief was to understand and learn from the innovative nature of the technical project outcome and then design innovative tailored garments with the resultant fabric. The results of the project were exhibited at the first FFF Showcase at Salts Mill in West Yorkshire in October 2019 (Figure 4).

Call 3: Numerion Software Ltd. – proof of concept

In the third Call of the scheme, a project was funded by Numerion and an academic with research expertise in virtual reality and augmented fashion. Numerion is a boutique dynamics consultancy based in Milford, UK (Numerion, 2021, n.pag). The aim of the project with FFF was to develop and explore how best to bring to market a virtual 3D garment draping service that worked for both the fashion industry and education as well as commercially for Numerion. One of the founders of Numerion, said,

> It's an interesting challenge. How do you create quality digital garments in four hours that would take a month in the film industry? The only solution is to have the infrastructure in place so the correct, approved, final design is there and ready to work with straight away. To use what we have at scale, the missing piece is an effective asset management system. (FFF, 2024, n.pag)

The prototype needed to be accessible and easy to use without the need for deep technical knowledge. Based on a market-leading garment simulation tool, used by

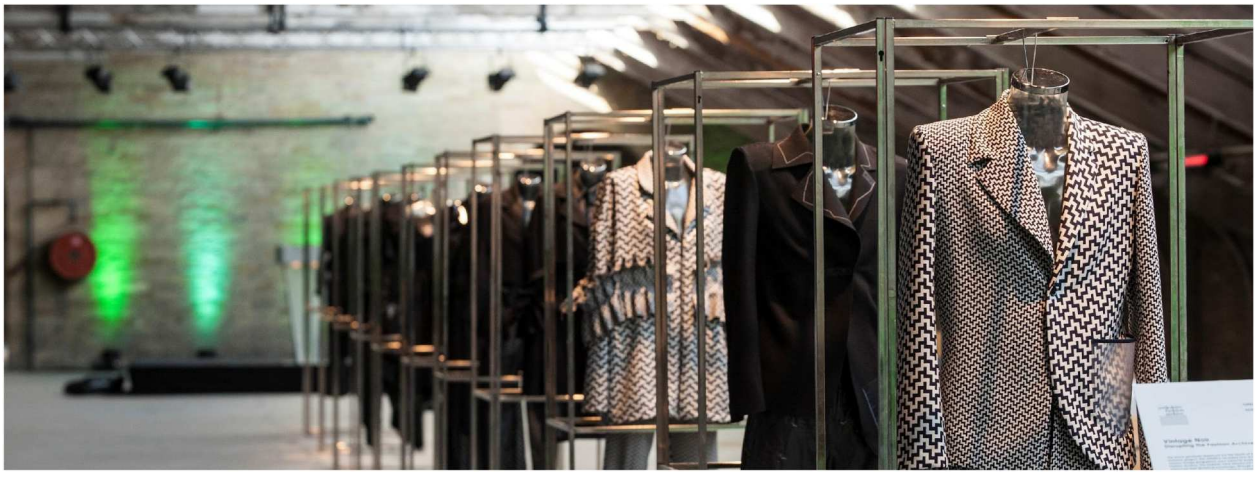

Figure 4. Digitised Jacquard Garments from the Responsive R&D Call 1 project, A.W Hainsworth & Yorkshire Textiles.

major movie studios, the new cloud-hosted 3D garment visualisation service would need to allow consumers and designers to engage with different styles on a webpage as part of an AR/VR/MR experience. This new platform would aim to reduce product lead times, waste from excessive sampling and customer return rates (Almond, 2022).

To enable data gathering, a focus group was established which consisted of leading fashion industrialists and educators. A mixed method (both qualitative and quantitative) questionnaire was sent to focus group members. This sought to both gather the thoughts of the respondents to some questions, plus the percentages of yes and no answers to others. The questionnaire looked to capture opinions on how the software could be developed in the future and how individual brands and educationalists would like to use the service and interact with it to deliver the best outcomes. The responses were utilised to improve and develop the user-interface prototype and were subsequently trialed with the focus group. The outcomes also identified the challenges facing the fashion industry as they seek to embrace live 3D simulation, and this informed the future development work. It enabled Numerion to identify a clear pathway to commercialisation for the 3D garment draping service. Numerion subsequently leveraged its FFF project outcomes to apply for further UKRI funding to develop it. Carbon Draper is now a significant service offered by the company (Numerion, 2024a). Figure 5.

Challenges

The challenges associated with the delivery of FFF's Responsive R&D grants can be broken down into three strands: operational challenges with the wider CICP; relationship building and maintenance; and conflicts between industrial expectations and standard HEI operational processes. Of these, the former was something specific to funder and CICP programme delivery whilst the latter two have been discussed widely within previous literature, albeit primarily with a STEM focus (Oliver & Barda, 2019; O'Dwyer, Filieri, & O'Malley, 2022).

- The CICP was a novel collaboration between the Industrial Strategy Challenge Fund (IUK, 2024) and AHRC (UKRI, 2024b), the first mechanism of its kind to directly allocate substantive funding to the creative industries. As such, due to the exploratory and innovation nature of the programme, several issues primarily around clarity of reporting and funder expectations had to be overcome. The iterative approach that organically developed in response, during the early years of CICP delivery did ultimately result in a robust benefits mapping evaluation approach.
- Industry-Academia Relationship Building and Maintenance is a well-known challenge within the literature, different approaches/drivers, timescales, and language being primary pain points. For FFF the ecosystem started with a small core of existing interactions between Yorkshire-based businesses and individual academics, and the support of UK sectoral bodies UKFT and BFC; the CEO of UKFT chairing the FFF Steering Group and Investment Committees. A carefully constructed series of engagement and dissemination mechanisms were introduced and iterated over the first years of delivery in relation to the Responsive R&D grants (Figure 3), which served to overcome initial cynicism about the value of industry-academic workings across the wider UK fashion and textile network.
- Challenges with Internal Higher Education Institutions (HEIs) systems added a further layer of complexity to the maintenance of ecosystem integrity. The novel approach taken by AHRC when contracting CRDPs drove non-standard HEI requirements necessitating more responsive timescales, different approaches to recognising co-created Intellectual Property, and a more flexible approach to managing academic staff time/buy-out processes. There were also elements of internal championing required of the benefits to be derived through working with SME industrial partners to co-develop solutions to real-world challenges.

These challenges identified and explored throughout the Responsive R&D projects resulted in the development of a robust, still growing and learning ecosystem. Iterative feedback loops from outcome communication and layered engagement activity maximised learning opportunities and helped to strengthen this system.

Outcomes

The varied outcomes developed through the Responsive R&D projects helped to stimulate, raise awareness of, and add value to the UK's creative sector; thus, ensuring they have the resourcing and skills-base required for sustainable growth. These evaluation themes, co-developed between AHRC, the nine CRDPs and an independent evaluator (BOP Consulting) using a benefits mapping approach, then fed through into five high-level benefits, detailed in Table 3, which capture the

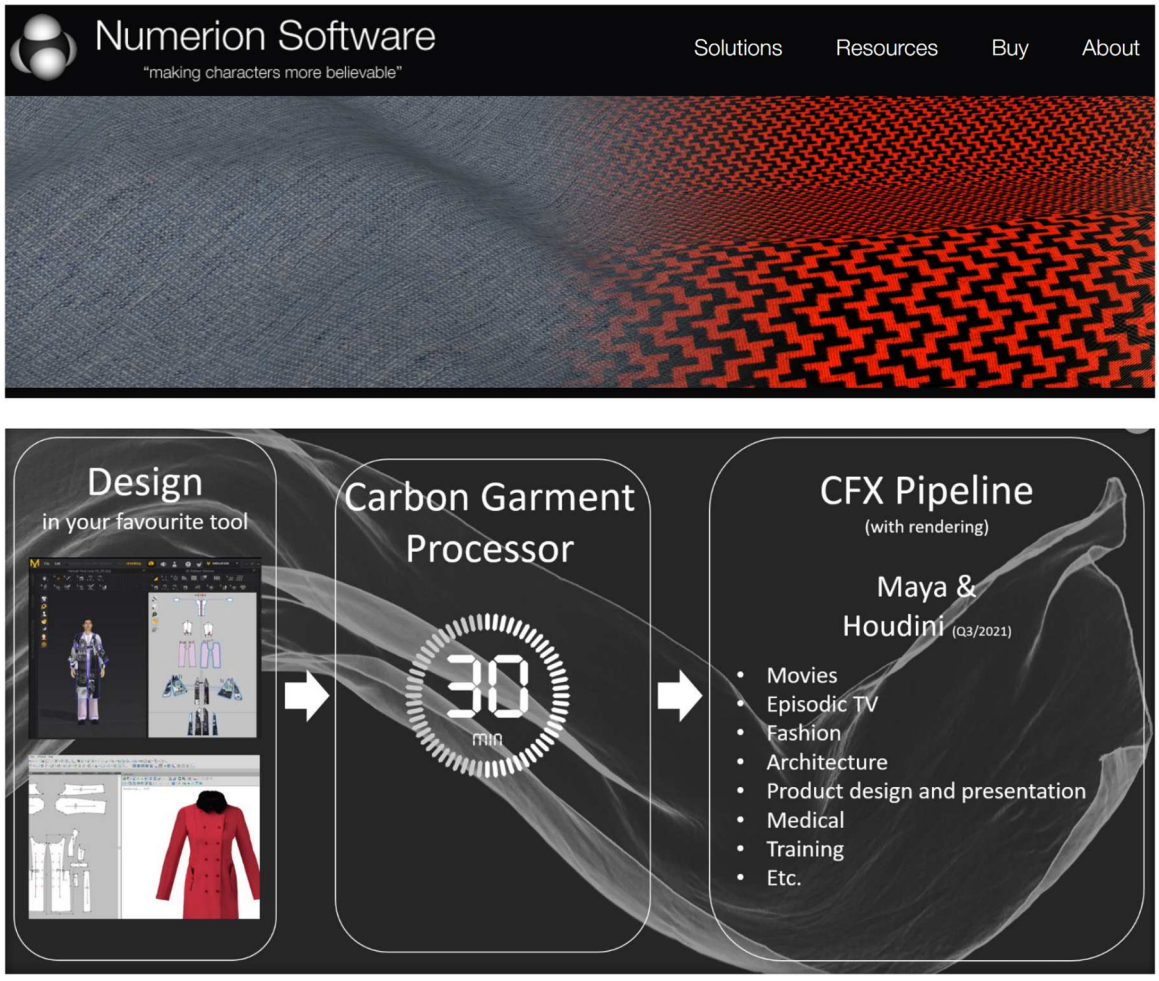

Figure 5. Numerion, Carbon Garment Workflows. Participation in the Eco System and how evidence of Activity was collated and analysed (Numerion, 2024b).

essence of the overarching CRDP key themes identified at the beginning of the FFF initiative.

For FFF, 'Benefit 4' was a strand running throughout the Responsive R&D grants, even though the extent of the FFF ecosystem is UK-wide (with some additional international partnerships), linkages back to the Yorkshire and Humber region are in-built to every deliverable. Other benefits though can be shown to be directly supported by FFF-specific Key Performance Indicators (KPIs), each of which was carefully designed at the outset of the CRDP development to record and demonstrate the significant impact for the sector that FFF was designed to stimulate. To provide examples of this approach: KPIs that reflect FFF's Skills and Education CRT, such as the embedding of learning within new and existing training opportunities (as detailed in the A.W. Hainsworth & Yorkshire Textiles Proof of Concept project), are aligned against the CICP Benefit 3. Alternately, KPIs that reflect activities designed to stimulate creative co-development leading to the adoption of innovative solutions align with CICP Benefit 1 (as detailed in the Numerion Proof of Concept grant) and demonstrate how they draw upon a wider range of activity occurring across multiple CRTs.

Table 3. CICP Key Benefits - developed from evaluation themes (BOP_Consulting, 2020, p. 7).

Benefit 1	Creation of an environment for new and experimental creative content, products, services and experiences
Benefit 2	Generation of long-term strategic, applied research partnerships and creative enterprises for Higher Education Institutes and other relevant sectoral and local stakeholders
Benefit 3	Improvement of creative and digital enterprises' ability to access the skills, knowledge and expertise they require to develop new products and services
Benefit 4	Key place-based/sector issues are addressed through applied research programmes
Benefit 5	Economic and social benefits are generated (including co-investment)

Conclusion

The rationale for this paper was to explore how the FFF funding system championed the development of an ecosystem to support sustainable change, establishing new

digital and advanced textile technologies to boost the design of high-value creative products in the UK fashion and textile industry. In doing so, it has highlighted the FFF CRTs that were identified as challenge areas to inform essential business requirements within the sector. The particular focus of the research was on one of these mechanisms, the Responsive R&D funding mechanism that enabled FFF to allocate funds to industrial members with projects aligned with the CRTs.

Through its integrated programme of CRT investigation, FFF has effectively fulfilled its mission to stimulate innovation within the target creative industry - UK Fashion & Textiles. Close industry and academic working relationships have been established and programme success is recognised by the UK Fashion & Textile Association (UKFT), 'Whichever way you look at FFF it has been an outstanding success', and 'FFF has driven a horse and cart through the idea that universities do not work to support industry' – CEO, UKFT (FFF, 2024, pp. 34–55). The industry – academic engagement mechanism is detailed within the two case studies that discuss the working relationships between the partners. In the case study example of the Hainsworth project, students were also an integral part of the activities as they were inspired by and used the digitised fabric to create a fashion collection.

As part of the CICP, FFF has provided data to inform the UK-wide benefits mapping approach, developed by CICP clusters working with AHRC to evaluate the impact of the £80 million investment, as well as speaking to more specific Key Performance Indicators contracted to its funding award. FFF has exceeded outcome targets: delivering 280% of new courses/course module targets and recording 142% of learners on these courses; evaluating 285% of the target for co-developed innovation projects; and leveraging 366% of the initial co-investment target. A network of 600 industry members was developed during FFF programme delivery as part of the sustainable ecosystem approach. These achievements are reflected in the contribution of the Responsive R&D projects awarded grants which have catalysed new thinking, practices and paradigms within the UK fashion and textile sector that have supported and developed the associated ecosystem. This has subsequently had a significant impact on the range and depth of the funding initiative and its application (i.e. attracting private-sector equity investment, leveraging further innovation funding and co-development of future skills programmes). Industrialists and educators become aware of the achievements of the Responsive R&D projects through their dissemination in outcomes such as designs and prototypes featured in publications and broadcasts and the adoption of FFF technology and design innovation within their activities in a global context. Triangulation of this impact through discussion with six fashion industry professionals who had not been involved in the research identified the significant opportunities for expansion within the global fashion and textile industry.

As a result of successes achieved through the Responsive R&D grants, and other FFF mechanisms, the delivery period for the FFF programme was extended to 31st May 2024 as additional funding was provided to commission further activity to prepare the fashion and textile sector for Net Zero transition. Outcome reporting continued into summer 2024 (UKRI, 2024a). In 2024, FFF was selected by Innovate UK to pilot a secondary funding mechanism, FFF Responsive R&D processes and methods have also informed Network Plus delivery, part of the £15M UKRI 'Circular Fashion and Textile Programme'. KPI methodology and benefit mapping have also continued within the Network Plus programme and activity continues to be measured through the reports (UKRI, 2023c). Engagement mechanisms developed within the FFF programme leveraged industry support to co-develop a new BSc Textile Innovation and Sustainability due to begin delivery in Autumn 2024 (UoL, 2024) which has attracted scholarship support from the Textile Livery Group (UKFT, 2024). FFF will continue as an important brand within the Leeds Institute of Textiles and Colour (LITAC). The FFF industrial network continues as part of the Institute, enabling LITAC to embrace future opportunities for creative innovation and continue to stimulate considerable growth and expansion of the ecosystem within the global fashion and textile industry.

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