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Evaluation of ISCF Audience of the Future: Design Foundations 2

Final Report

Nadya Mihaylova, Rita Cimatti (Technopolis), Richard Naylor, Lizzie Parker (BOP)

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Table of Contents

Tables

Figures

Executive Summary

This report

This is the final report of the evaluation of the Audience of the Future Challenge's Design Foundations 2 (DF2) competition.

The scope of the evaluation is to assess the extent to which the competition is making or has made an impact considering its original aims. The evaluation aims to test the extent to which the programme delivers the outcomes and impact for industry and the extent to which these are attributable to the ISCF funding.

This report presents the emerging findings relating to the DF2 projects' outputs and outcomes. The findings are based on a survey of successful and unsuccessful applicants, in-depth interviews with five award-holders and one former member of the UKRI delivery team, monitoring data, and case studies.

The Audience of the Future's Design Foundations 2 competition

Audience of the Future (AotF) programme was launched in March 2018 as part of what was originally the Industrial Strategy Challenge Fund (ISCF), to support the development of immersive content and experience, and the UK-based creative sector. Originally funded through £33m of UKRI investment, an additional £6m was made available to support companies affected by the COVID-19 pandemic. Some of these additional funds have been used to run a new competition which builds on and tests other propositions. This competition is a second round of the Design Foundations competition, Design Foundations 2 (DF2).

The **Design Foundations 2** competition supports early-stage projects that use customer research and established human-centred design principles to test the feasibility of generating new immersive experiences, products, and services.[1] Projects were supported with £25k-£50k and ran for 2 to 3 months, between January and March 2022. The projects were required to use human-centred designed principles in developing their idea, in particular the Design Council's 'double diamond' process and in recognition of the broader social and political context, focussed on three thematic areas: Net Zero, Build Back Better or Cross Sector.

The Design Foundations 2 competition supported 33 projects and committed a total of £1.1m of AotF funding and leveraged a further £484,864 from project participants. The awarded projects involve 39 participants, the majority of which are businesses (37) and the remaining two are universities. Most participating businesses are 'micro or small' in size (89%, 33/37).

Final evaluation results

Overall, participants reported positive impacts derived from their involvement in the DF2 programme.

The survey results indicate that the programme has been successful in **enhancing existing partnerships and facilitating connections with new partners**, as well as expanding participants' network into previously unexplored organisation types. According to survey responses, each DF2 programme participant has been involved in an average of six collaborations, resulting in a total of 133 partnerships. Assuming that non-responding participants have similar collaboration patterns, we can infer that the programme has played a key role in supporting more than 200 partnerships. Close to 100% of surveyed participants believe that their DF2

[1] https://apply-for-innovation-funding.service.gov.uk/competition/1001/overview

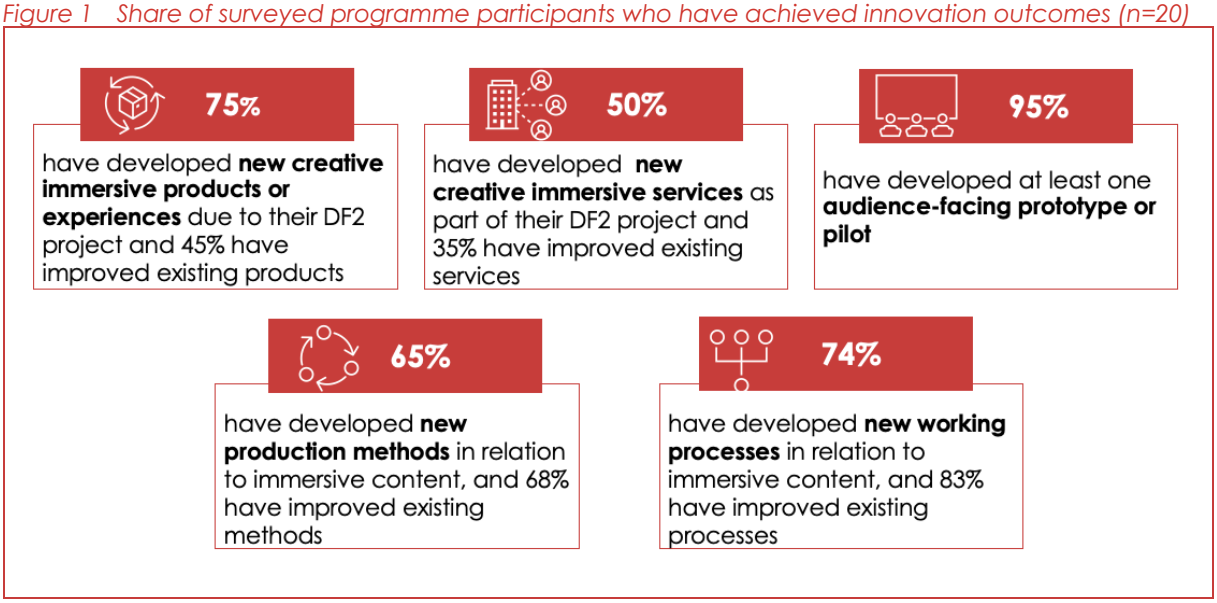
project has enhanced their partnerships and most confirmed that they see avenue for future collaboration with their partners.

Evidence collected from the survey shows a **good uptake of new skills and internal capabilities** developed due to participation in the programme. Except for one participant, all surveyed respondents stated that their involvement in the programme has led to new skills among staff and improved internal capabilities within their organisations/research groups (with roughly half saying this has happened to a large extent). Most also indicated that they have developed a better understanding of their customers or stakeholders to a large extent (75%) or to some extent (25%).

Funded projects have made very good progress in terms of their **Technology Readiness Levels (TRLs).** Since the start of the programme, 90% (18/20) of participants have progressed at least one level, compared to 41% (12/29) of unsuccessful applicants. As of April 2023. 25% of participants have reached TRL 9 (i.e. commercialisation stage) and further 50% have reached TRL 7 – 8 (i.e. demonstration in real environment stage). This is in stark contrast to unsuccessful applicants, 28% (8/29) of whom have not continued with their project, with further 31% still being in the early stages of development (i.e. TRL 1 – 6).

Figure 1 illustrates the share of surveyed successful applicants who have **developed innovations** which can have significant positive impacts on organisations' bottom line, as well as their ability to compete in the marketplace. To date, programme participants have successfully developed 24 new products and 15 new services and have made improvements to 10 existing products and 11 existing services due to their DF2 projects. Most programme participants (60%, 12/20) reported that these new products or services have applications in other industries and further 30% expect to find cross-sector applications in the future.

Figure 1 Share of surveyed programme participants who have achieved innovation outcomes (n=20)



There is evidence **that innovations have already translated into additional sources of income.** This represents a significant programme achievement considering that all DF2 projects were early stage / scoping studies. When participants were queried about the financial gains of innovations:

- 40% (8/20) reported that the activities supported by the programme have led to **new revenue streams from new product or services, or new customers**, and another 55% stated they expected to achieve this in the future. Four companies reported a combined financial

gain worth £210k (an average of ~£26k per organisation), and the remaining four companies reported no gains.

- 50% (10/20) have produced **new Intellectual Property (IP) rights and/or exploitable trade secrets** and slightly more than a third expect to benefit in the future. Three companies reported a combined financial gain worth around £511k, with the remaining seven reporting no financial returns at the time of the survey.
- 25% (5/20) have **developed new immersive platforms** as part of their DF2 project. Two respondents reported a combined financial return close to £15k, and the remaining three reported no gains. Around 60% expect to develop new platforms in the future.
- 65% (13/20) have **trialled or demonstrated new business models**, with a combined financial gain of £260k (average of £20k per organisation). Further 15% reported that they have plans test novel business models in the future, but for 20% this seemed unlikely.

One of the unique aspects of the DF2 programme is the requirement to **incorporate design methodologie**s into the projects' core activities. The survey found that 91% (18/20) of programme participants have implemented design processes or invested in professional design services since applying to the programme, up from 78% prior to the application. Examples of how organisations have implemented design methodologies to understand the motivations and challenges experienced by customers include user testing and validation activities, user surveys, interviews and stakeholder workshops, design research and prototyping.

Surveyed programme participants indicated that the adoption of design processes has significantly (60%) or moderately (20%) improved their ability to communicate the value of their project to investors, funders or customers. The findings from the qualitative interviews also demonstrated examples of the programme's success in supporting companies to recognise the value of design methodologies in their DF2 projects and beyond. Feedback received from interviews suggests that design methodologies have become more integrated into business models and plans, resulting in valuable lessons that are actively being applied to new projects.

The qualitative interviews also revealed that the adoption of human-centred design methodologies has had positive impacts on the project outcomes, the companies involved, and the wider public. Feedback indicated that Equality, Diversity, and Inclusion (EDI) considerations emerged organically through DF2 project research even when this topic had not been something companies had set out to explore as part of their projects. User-testing research has indicated that products supported by the programme have significant potential to improve the accessibility of live experiences for people of all communities and backgrounds, reducing the risks that segments of the populations are left out. These findings emphasise the benefits of incorporating human-centred design principles on project success, as well as broader benefits to society resulting from the development of products/services that are more accessible, equitable, and user-friendly.

The survey results indicate that DF2 programme participants have gained a larger absolute increase than unsuccessful applicants in the median value of **turnover** (£60k vs £14k) and turnover derived from immersive content or technologies (£47,500 vs £27,500). The funding has supported strong **employment benefit** in terms of both job and income growth.

Results from the survey indicate that the programme has helped to leverage additional **investment into R&D** for creative immersive products and experiences. Successful applicants reported a median value of R&D investment in creative content of £300k, a significant increase from the baseline position of £70k. Over the same period, the median value for unsuccessful applicants has stayed the same, at £25k. This substantial increase in R&D spending positions programme participants for future TRL progression and significantly enhances their prospects for successful commercialisation of both new innovations and those specifically supported by the programme.

1 Introduction

1.1 The competition

Audience of the Future (AotF) programme was launched in March 2018 as part of what was originally the Industrial Strategy Challenge Fund (ISCF), to support the development of immersive content and experience and the UK-based creative sector.

The programme aims to capture new global audiences and grow the UK's leading market position in creative content through supporting the development of next generation products, services and experiences in AR, VR, MR and haptic technologies. The programme is comprised of three areas of investment: StoryFutures Academy (formerly The National Centre for Immersive Storytelling), four large 'Demonstrator' projects, and a smaller programme of Grants and Investments, which included the Design Foundations competition.

The programme's high-level objectives are:

i) The UK will become a dominant market leader in the creative immersive sector by 2025, creating 10% of global creative immersive content and become a net exporter of Immersive content;

ii) The UK has an increased skilled workforce to create immersive content, that will lead to the UK becoming the number 1 destination in Europe for investment in immersive content production;

iii) Increased private investment in immersive technology, so that the UK will double its share of global investment in immersive technologies.

Originally funded through £33m of UKRI investment, an additional £6m was made available to support companies affected by the COVID-19 pandemic. Some of these additional funds have been used to run a new competition which builds on and tests other propositions. This competition is a second round of the Design Foundations competition, Design Foundations 2 (DF2).

1.2 The evaluation

The scope of the evaluation is to assess the extent to which the Design Foundations 2 competition has made an impact, taking into account its original aims. The evaluation tests the extent to which the programme has delivered the outcomes of the delivery plan and the extent to which these are attributable to funding provided through the competition.

1.2.1 This report

This final report draws from three primary sources of information and analysis:

- **CATI Survey** completed by successful and unsuccessful applicants between March and April 2023.
- **Six in-depth interviews** completed with a selection of five grant-holders and one former member of the UKRI delivery team.
- **Five case studies** which combine information from the project application, project completion forms, additional DF2 form, and interview(s) with project participants.

The remainder of this report is organised as follows:

- **Section 2** presents an **overview of the DF2 competition** and the funded portfolio of projects.
- **Section 3** presents the **outputs and outcomes of the DF2 projects** roughly one year after the project close

Appended to the report are: 0, the full length DF2 case studies; 0, a summary table of all indicators collected for the final evaluation; 0, the profile of respondents to the CATI survey.

1.2.2 Methodological considerations

The information presented in this report is based on a relatively low number of responses. Given the small size of the Design Foundations strand, the number of responses secured to the survey was relatively low. As such we primarily focus on presenting median values of those indicators to mitigate the effect of potential outliers on mean values.

Given the small nature of the strand and the sample, the results need to be taken with caution. However, this information still goes some way to providing insights into the outcomes and impacts of the programme overall.

Any financial values and estimates reported in the survey should also be treated with caution. The values employed for this report are *untreated* and have not been validated.

2 The Design Foundations 2 competition

The **Design Foundations 2** (DF2) competition supports early-stage projects that use customer research and established human-centred design principles to test the feasibility of generating new immersive experiences, products, and services.[2]

Projects are supported with £25k-£50k and run for 2 to 3 months, between January and March 2022. Projects must include activities or work packages that:

- discover customer perceptions, motivations, and behaviour
- define the problem statement and pinpoint the characteristics necessary to make any solution desirable and fit for purpose
- deliver clearly communicated ideas that have been validated through fast, low-cost prototyping and user-testing, and are ready for further technical R&D.

The projects were required to use human-centred designed principles in developing their idea, in particular the Design Council's 'double diamond' process.

In recognition of the broader social and political context, the DF 2 competition was focussed on three thematic areas; projects were required to explore at least one theme. These thematic areas are summarised below. These thematic areas were selected to focus the competition on addressing specific needs or challenges of societal relevance, namely the impact of the COVID-19 pandemic on live venues and increased importance of addressing climate change.

Table 1 Design Foundations 2 thematic areas

Thematic Area	
Designing for Net Zero	• Behaviour-change, by exploring new ways of living and working in cities, homes, and offices • Storytelling, using the power of creativity to tell different stories about environmental impact and net zero • World-building, using extended reality (XR) to imagine different futures through which to engage multiple-actors
Design for Build Back Better	• New products, services, or experiences, that support live venues and performance spaces, in the creation and delivery of immersive content • Methods, processes, and adaptations, for hybrid revenue streams post COVID-19 • Products, services, or technologies, which support distributed audiences and multichannel revenue models • Content delivery systems, that allow audiences to feel connected and part of a shared community experience
Design for Cross Sector Immersive Projects	• Enable the development of new products and services by applying immersive and associated technologies developed for the creative industries and then applied in other industrial sectors • Design prototyping studies for products, services and experiences in healthcare, education, mobility, transport, energy, or manufacturing

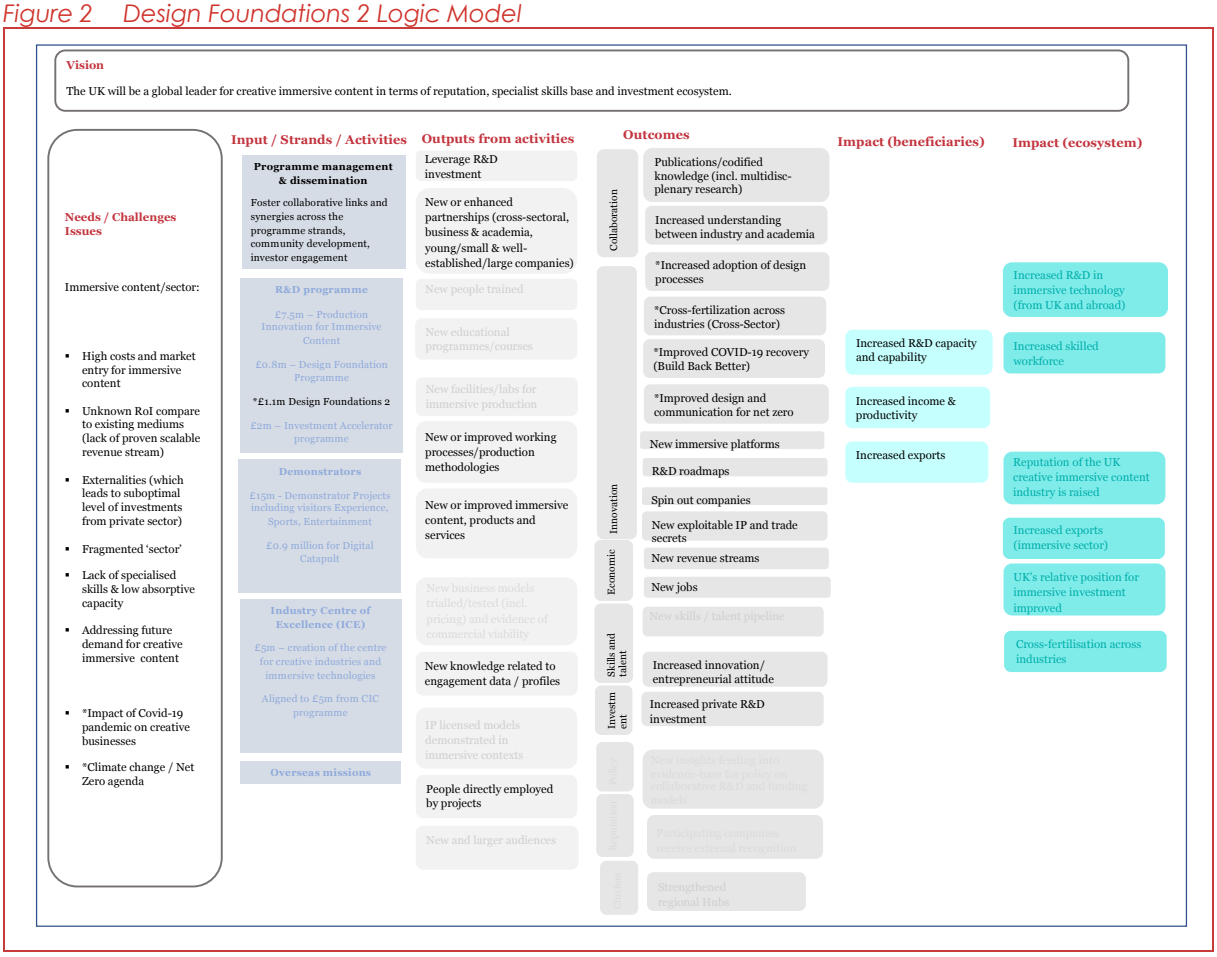
Source: Audience of the Future – Design Foundations 2, competition overview

Figure 2 presents the overall logic model for the DF2 competition. This version of the logic model builds on the logic model developed for the Audience of the Future programme evaluation, whilst taking in account the specific focus of the DF2 competition. New elements of the logic model added specifically for the DF2 competition are marked with an asterisk*.

[2] https://apply-for-innovation-funding.service.gov.uk/competition/1001/overview

As a key component of the AotF programme, the DF2 competition also contributes to the programme level impacts upon the wider ecosystem. Given the scale of the competition however, it is unlikely that any impact upon the wider ecosystem could be attributed to the DF2 competition.

Figure 2 Design Foundations 2 Logic Model



2.1 Portfolio of Design Foundations 2

The Design Foundations 2 competition has committed a total of £1.1m of AotF funding from UKRI and leveraged a further £484,864 from project participants. Of the 93 applications, 33 were awarded (35% success rate).

Table 2 Investment per project

Total cost* of projects	Total ISCF AotF Funding from UKRI	Total investments from companies	Average cost* per project	Average cost* per organisation
£1,570,661	£1,085,797	£484,864	£46,196	£40,273

Source: Technopolis (2022) based on client data. * The cost figure includes ISCF AotF funding from UKRI and investments from companies.

All projects must be led by a UK registered business and include at least one registered SME partner. Applicants were limited to lead on one application but could be included as a collaborator in a further two applications. Among the 33 awarded projects, six projects also included a partner organisation.

The awarded projects involve 39 participants, the majority of which are businesses (95%, 37) and the remaining 5% are universities (2). The vast majority of participating businesses are 'micro or small' in size (89%, 33). The average total cost per project is £46,196, while the average total cost per participant is £40,273.

Table 3 Unique participating organisations and funding

Type	Number of unique participants	%	Total cost* of projects	%	Total ISCF AotF Funding from UKRI	%	Total investments from companies
Micro or small business	33	85%	£1,472,586	94%	£1,023,810	94%	£448,776
Medium business	4	10%	£82,367	5%	£49,420	5%	£32,947
All business	37	95%	£1,554,953	99%	£1,073,230	99%	£481,723
Academic	2	5%	£15,708	1%	£12,566	1%	£3,142
Total	39	100%	£1,570,661	100%	£1,085,797	100%	£484,864

Source: Technopolis (2022) based on client data. * The cost figure includes ISCF AotF funding from UKRI and investments from companies.

2.1.1 Thematic focus of DF2

At the proposal stage, across the three thematic areas in scope, most projects are associated with 'Build Back Better' (54%) or 'Cross Sector' (49%). Around a quarter of projects were linked to the Net Zero (23%) area. Eight projects are linked to more than one thematic area, three of which apply to 'All' thematic areas.

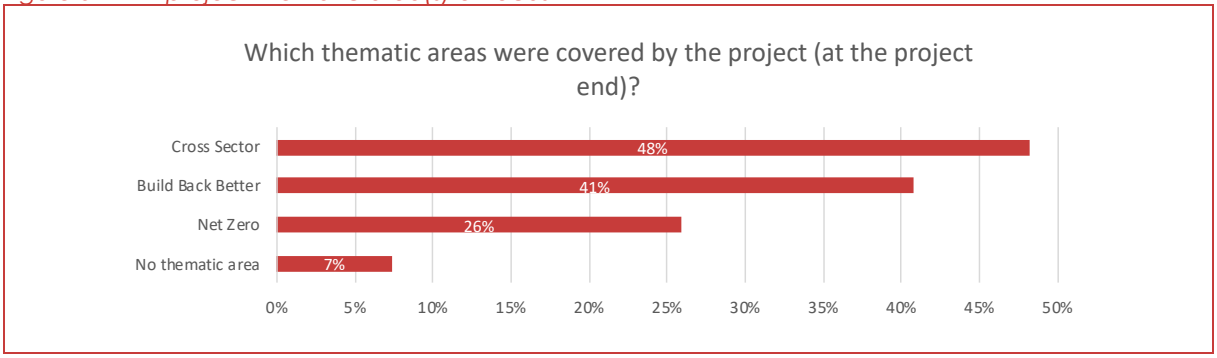
Table 4 Number of projects by thematic area (at proposal)

Thematic area	Number of projects	% of projects *
Build Back Better	21	54%
Cross Sector	19	49%
Net Zero	9	23%
Total	***33****	

Source: Technopolis (2022) based on client data. * Excluding one project without an indicated thematic area. ** sum exceeds 100% due to overlaps in thematic areas

At the end of their DF2 projects, participants were asked again which thematic areas were addressed. Of the 25 projects that completed the DF2 post-project form, 17 (63%) indicated they had covered the same thematic areas proposed in their application. For those which indicated a change in their thematic focus, 4 projects reported addressing additional thematic area(s), whilst 5 projects reported addressing fewer than at the proposal stage.

Figure 3 DF2 project thematic area(s) of focus



Source: DF2 Post-Project Form, 2022, base: 27

3 Outputs and Outcomes of the DF2 competition

This section presents the findings relating to the DF2 projects' outputs and outcomes roughly one year after the projects closed (March - April 2023). These outputs and outcomes are those collected from a CATI survey with successful and unsuccessful applicants, and from five in-depth interviews with a selection of grant-holders.

3.1 Collaborations

One of the programme's objectives is to support **new and enhanced collaborations** with different types of partners. According to the survey, almost all successful applicants (95%, 19/20) collaborated with at least one other type of organisation as part of their DF2 project. Approximately half of respondents reported collaborating with one to five organisations, while the other half reported collaborating with more than five organisations. According to survey responses, each DF2 programme participant has been involved in an average of six collaborations, resulting in a total of 133 partnerships. Assuming that non-responding participants have the same average number of collaborations, we can infer that the programme has supported a total of 234 partnerships.

Most of the collaborations supported through the funding were with new partner(s) (78%, 104/133) which suggests that the programme has provided a platform to strengthen existing relationships and build new ones. For successful applicants, the programme has also provided an opportunity to collaborate with different types of organisations that they had not collaborated with before. As shown in Table 5, roughly half of respondents said that their DF2 project was the first time they had collaborated with either a micro businesses or academia.

The in-depth interviews with grant-holders also revealed positive examples of collaboration benefits. For example, one beneficiary worked with a small tech firm for the first time through their DF2 project. This was an experience they describe as 'really invaluable', as it enhanced the team's technical understanding and introduced them to new ways of working and managing projects. Similarly, another company began their DF2 project with three partners but reported more than thirty partners by the time the project concluded.

"And in terms of achievements, we had all these partners by the end... we had councils getting involved, schools... it was just absolutely staggering."

Table 5 Collaboration outcomes for surveyed programme participants

Type of partner organisations	% of respondents who collaborated with this type of organisations as part of DF2 project	% of respondents who collaborated with this type of organisation for the first time
Micro businesses (1 to 9 employees)	84% (16/19)	47% (7/15)
Small or medium businesses (less than 250 employees)	44% (8/18)	29% (2/7)
Large businesses (more than 250 employees)	24% (4/17)	100% (3/3)
Academic research group or Public Research Organisation	61% (11/18)	56% (5/9)
Charity or public sector organisation	29% (5/17)	25% (1/4)

Other	6% (1/17)	0% (0/1)

Source: Technopolis analysis using CATI survey.

According to the survey, 17 micro businesses have developed a total of 116 partnerships as part of their DF2 project, the majority of which were with charity or public sector organisations (38) and other micro businesses (32). Similarly, three surveyed small or medium businesses have developed a total of 17 partnerships, most of which were with other SMEs (9) or micro businesses (5).

Table 6 Number of partnerships developed by surveyed participants

Type of partner organisations	Total number of partnerships developed by surveyed micro businesses	Total number of partnerships developed by surveyed small or medium businesses	Total number of partnerships developed by all surveyed DF2 participants	% of partnerships that are new
Micro businesses (1 to 9 employees)	32	5	37	76%
Small or medium businesses (less than 250 employees)	12	9	21	57%
Large businesses (more than 250 employees)	5	0	5	80%
Academic research group or Public Research Organisation	17	2	19	84%
Charity or public sector organisation	38	1	39	82%
Other	12	0	12	100%
Total	**116**	**17**	**133**	**78%**

Almost all survey respondents (94%, 17/18) either strongly agreed or agreed that their project has enhanced their partnerships and most confirmed that they see avenues for future collaboration with their partners. Evidence from the qualitative interviews also suggests that many of the partnerships formed through DF2 are ongoing. For example, one company reported that they have remained in contact with some of the industry stakeholders they consulted with as part of their DF2 research, some of whom are now playing an active role in guiding the future of the company.

"We did these discovery interviews with a range of industry experts. A couple of them are now on our steering board, so they've helped form very long relationships coming off the back of it."

In terms of collaboration between industry and academia, one business reported that while on an individual level their collaboration with an academic researcher had been 'brilliant', it had been very challenging navigating the grant approval process with the university.

Box 1 Case study summary: Distributed Stiches

Distributed Stitches – Pattern Project ltd.

Pattern Project is a South London 'micro-factory' which facilitates clean, urban and local manufacturing of clothing using proprietary manufacturing techniques to produce small batch customised clothing.

Through their DF2 project, Pattern Project undertook testing and research with both designers and customers to identify key challenges with fitting clothes. This testing then informed the development of an algorithm capable of designing a custom-fit skirt which was installed in a pop-up shop pilot project of the prototype. This provided the platform for Pattern Project to explore the potential business models for in-store on demand clothing manufacturing.

The project revealed **unexpectedly high levels of interest in Pattern Project from small designers and brands** who were interested in small production runs for their designs. As a result the company are planning to explore an alternative business model based on B2B sales further, potentially including licensing the technology. The interest from other businesses in the technology has also resulted in **two new collaborations with external designer studios**, with the **resulting products to be released in the Summer of 2022**.

Full case study available in 0

3.2 Innovation

3.2.1 Technology readiness levels (TRLs)

The analysis of TRL data at the point of DF2 application and today reveals encouraging results for programme participants. Prior to the programme, most participants (90%) were in TRL levels 1 – 4, indicating early-stage development of innovations. However, after receiving the programme funding, only 10% have remained at these lower TRL levels and 90% have shifted towards higher TRL levels 5 - 9. The findings suggest that almost all surveyed participants (90%, 18/20) have moved up the TRL scale by at least one level since their DF2 project started. These findings indicate that the programme funding has effectively accelerated the technology development process for participants, leading to a higher proportion of businesses reaching more advanced stages of technological maturity.

In contrast, 28% (8/29) of unsuccessful applicants have not continued with their DF2 projects. Among these unsuccessful applicants, 3 were at the early stages of development (TRL 1 -4) and 5 had reached more advanced stages (TRL 5 – 9) at the time of applying to the programme. There are multiple factors that could explain their decisions to discontinue their projects, including technological challenges, resource / funding limitations, or external circumstances. A lower share of unsuccessful applicants (41%, 12/29) have progressed on the TRL scale by at least one level, compared to successful applicants.

Figure 4 TRL progression for successful and unsuccessful applicants

	Successful applicants		Unsuccessful applicants	
	At the point of application (n=20)	**Today (n=20)**	**At the point of application (n=29)**	**Today (n=29)**
Feasibility [TRL 1-2]	40%	5%	31%	7%
Proof of concept [TRL 3-4]	50%	5%	34%	10%
Demonstration for initial validation [TRL 5-6]	5%	15%	17%	14%

Demonstration in real environment [TRL 7-8]	5%	50%	7%	24%
Commercialisation [TRL 9]	0%	25%	3%	7%
Don't know	-	-	7%	10%
Has not continued with project	-	-	-	28%

Source: Technopolis analysis using CATI survey.

Table 7 TRL progression for successful applicants

	TRL today					
TRL at the point of application	Feasibility [TRL 1-2]	Proof of concept [TRL 3-4]	Demonstration for initial validation [TRL 5-6]	Demonstration in real environment [TRL 7-8]	Commercialisation [TRL 9]	**All**
Feasibility [TRL 1-2]	1	1	1	1	4	**8**
Proof of concept [TRL 3-4]			2	7	1	**10**
Demonstration for initial validation [TRL 5-6]				1		**1**
Demonstration in real environment [TRL 7-8]				1		**1**
Commercialisation [TRL 9]						
All	**1**	**1**	**3**	**10**	**5**	**20**

Source: Technopolis analysis using CATI survey.

Table 8 TRL progression for unsuccessful applicants

	TRL today							
TRL at the point of application	Feasibility [TRL 1-2]	Proof of concept [TRL 3-4]	Demonstration for initial validation [TRL 5-6]	Demonstration in real environment [TRL 7-8]	Commercialisation [TRL 9]	Has not continued with the project	Don't know	**All**
Feasibility [TRL 1-2]	2	1	2	2		2		**9**
Proof of concept [TRL 3-4]		2	1	2	2	1	2	**10**

Demonstration for initial validation [TRL 5-6]			1	2		2		**5**
Demonstration in real environment [TRL 7-8]						2		**2**
Commercialisation [TRL 9]						1		**1**
Don't know				1			1	**2**
All	**2**	**3**	**4**	**7**	**2**	8	3	**29**

Source: Technopolis analysis using CATI survey.

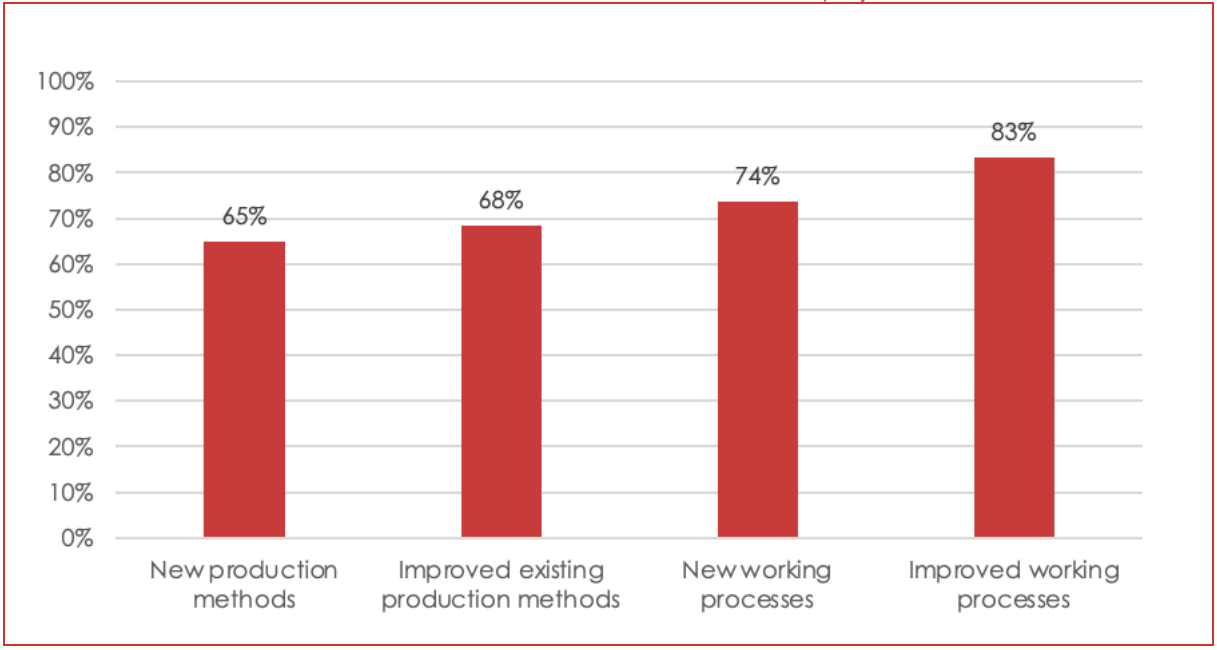
3.2.2 *New and improved methods and processes*

As a result of the DF2 programme, around two-thirds of successful applicants have developed **new or improved production methods** in relation to creative immersive content.

From the 20 survey participants, 74% have developed **new working processes** and 83% have improved existing working processes in relation to creative immersive content.

For example, one business report having been able to leverage the technical approaches they developed through DF2 and apply them to the development of other creative immersive experiences, including a commission for a public funder that supports user-generated content.

Figure 5 Share of successful applicants who developed new/improved methods or processes in relation to creative immersive content as a result of their DF2 project



Source: Technopolis analysis using CATI survey.

3.2.3 *New and improved creative or immersive products/services and prototypes or pilots*

Most participants have developed at least one **new creative immersive product or experience** due to their DF2 project (75%, 13/20). The programme has supported the development of 24

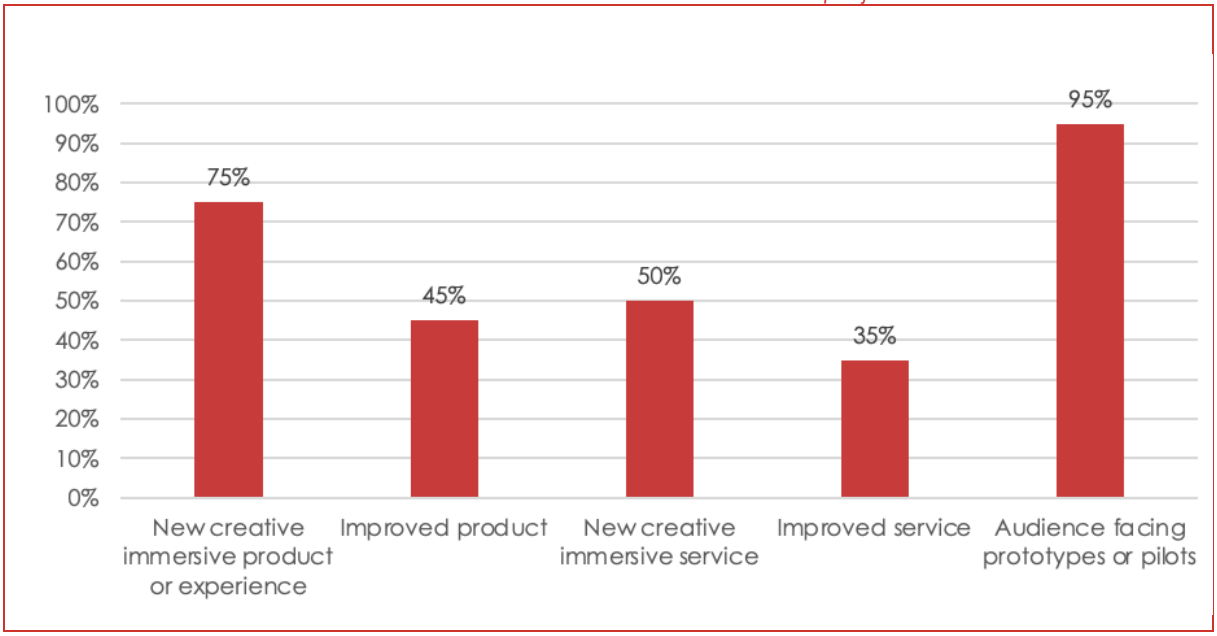
new products or experiences, with a quarter of respondents reporting more than one such innovation. 11 organisations (45%) have improved an existing product.

Half of participants have developed at least one **new creative immersive service** as part of their DF2 project and 35% have improved an existing service. In total, programme participants have developed 15 new services and have improved 11 services.

Most programme participants (60%, 12/20) reported that these new products or services have applications in other industries and a further 30% expect to find cross-sector applications in the future.

Except for one participant, all surveyed respondents said that they have developed at least one **audience-facing prototype or pilot** (average: 1 per business, total: 23).

Figure 6 Share of successful applicants who developed new/improved products and services in relation to creative immersive content as a result of their DF2 project



Source: Technopolis analysis using CATI survey.

3.2.4 *Outputs and revenue streams*

As part of their DF2 project, around two-thirds of respondents have **trialled or demonstrated new business models**. A further 15% reported that they have plans to do so in the future, but for 20% this seemed unlikely. In terms of the financial returns, around 65% (13/20) have reported gains from new business models, with a combined value of £260k and an average of £20k per organisation. As part of an in-depth interview, one business described the way in which the development of a prototype product is enabling them to innovate their business model in a way that would not have been possible without the project.

"It definitely changes our business model as well […] which was already part of our business strategy. But we didn't know how we were going to solve the issue with the tech. So the opportunity came along at a really good time."

Similarly, another business have been able to trial new business models and develop a better understanding of their potential user base through the project, which has influenced subsequent R&D.

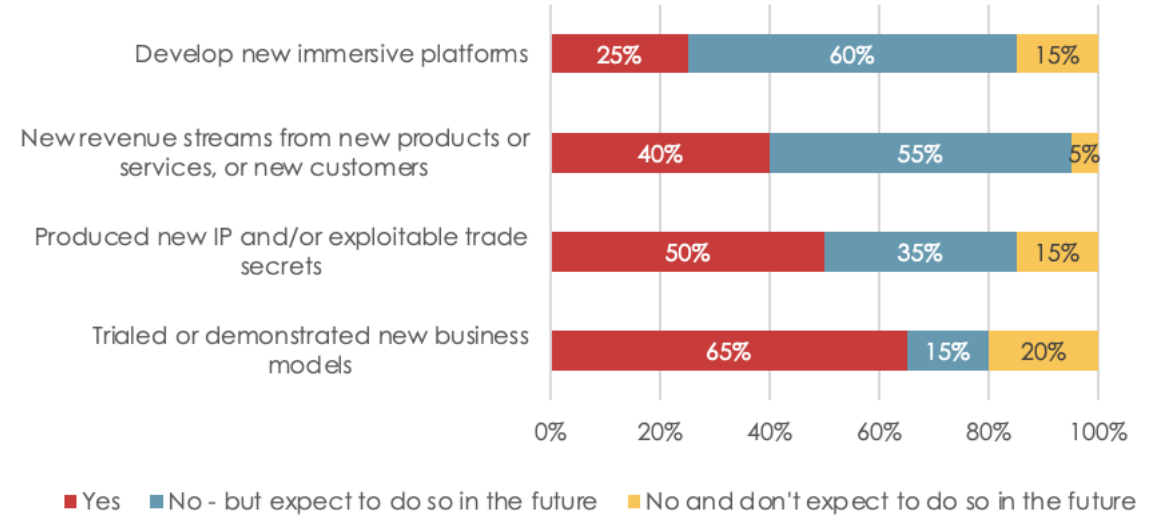
> ***"That is an area that we are developing and researching more in … and that's something that wasn't part of our thinking at all at the beginning."***

From the 20 surveyed successful applicants, half have produced **new IP and/or exploitable trade secrets**. Three companies reported a combined financial gain worth around £511k, with the remaining seven reporting no financial returns at the time of the survey. Slightly more than a third expect to achieve IP benefits in the future.

Around 40% of DF2 participants have discovered **new revenue streams from new products/services or customers**, and further 55% reported that they expect to achieve this in the future. Four companies reported a combined financial gain worth £210k (an average of ~£26k per organisation), but four other companies said they had not generated any financial gains yet.

A quarter of respondents said that they have **developed new immersive platforms** as part of their DF2 project. From them, two respondents reported a combined financial return close to £15k, and the remaining three reported no gains.

Figure 7 Output activities supported by the programme



Source: Technopolis analysis using CATI survey.

Box 2 Case study summary: Volume

Volume - Sage Gateshead/North Music Trust and Dimension Studio

The **'Volume'** project was prompted by the 'Audience of the Future' report, The Immersive Audience Journey, which stated the importance of placing audiences at the centre of creative content. In light of the impact of the COVID-19 pandemic, the performing arts venue Sage Gateshead/North Music Trust (SG/NMT) set up a collaboration with the volumetric and virtual production company Dimension Studio, with additional support from

the digital production studio Proto, to develop high quality immersive experiences that would enable SG/NMT to produce virtual content.

The project applied volumetric capture technology to a classical musician playing the cello, which was then tested with audiences who provided feedback about their experiences. These learnings would then inform innovation and foster the conditions under which AR experiences can happen at scale.

Due to technical challenges of using volumetric capture for reflective surfaces (namely, the cello), **Dimension Studio** had the opportunity to refine and develop one of their pre-existing post-production tools, which resulted in an **improved production process** called "light baking", which allows a higher quality in volumetric capture, maintaining a higher level of fidelity to movements and the real object. This is **now being integrated into all the company's projects** in the area of volumetric capture and distributed as a usable tool for future projects with **applications in other industries** such as web, AR, VR, broadcast and film.

For SG/NMT the biggest learning was the improved understanding of the market and that it is now easier for the team to understand skill needs and requirements for innovation, leading to a fuller visualisation of the organisation's strategic future.

Full case study available in 0

Box 3 Case study summary: Filament

Teaching the next generation about sustainability through Mixed Reality story-based play- Filament P.D.

Filament P.D. is a product design agency specialising in connected hardware. Prior to their DF2 project Filament had developed IP that used mixed physical-digital play to teach children about developing good financial habits, however felt there was scope to expand this model to address other habit-based learning to include sustainable habits.

The objective of Filament's DF2 project was to test and iterate this IP based on user and stakeholder feedback. Filament used their DF2 project to undertake design sprints with children and parents to consider how users would interact with the technology in parallel with **interviews and workshops with potential commercial partners to explore the potential business models and propositions for the future**.

As a result of their user testing, Filament **developed three new models** for how their concept could be developed and commercialised that included 'in store', 'at home' and community-based models. Their DF2 project also highlighted that whilst the 'in store' option was not necessarily workable for most retailers, the unique shop floor journey and strategic sustainability goals of a major furniture retailer were well aligned and conversations regarding an in-store test are ongoing. Filament have already identified further use cases for the MR concepts they have developed and are exploring potential applications of the technology for companies to better communicate with their user base.

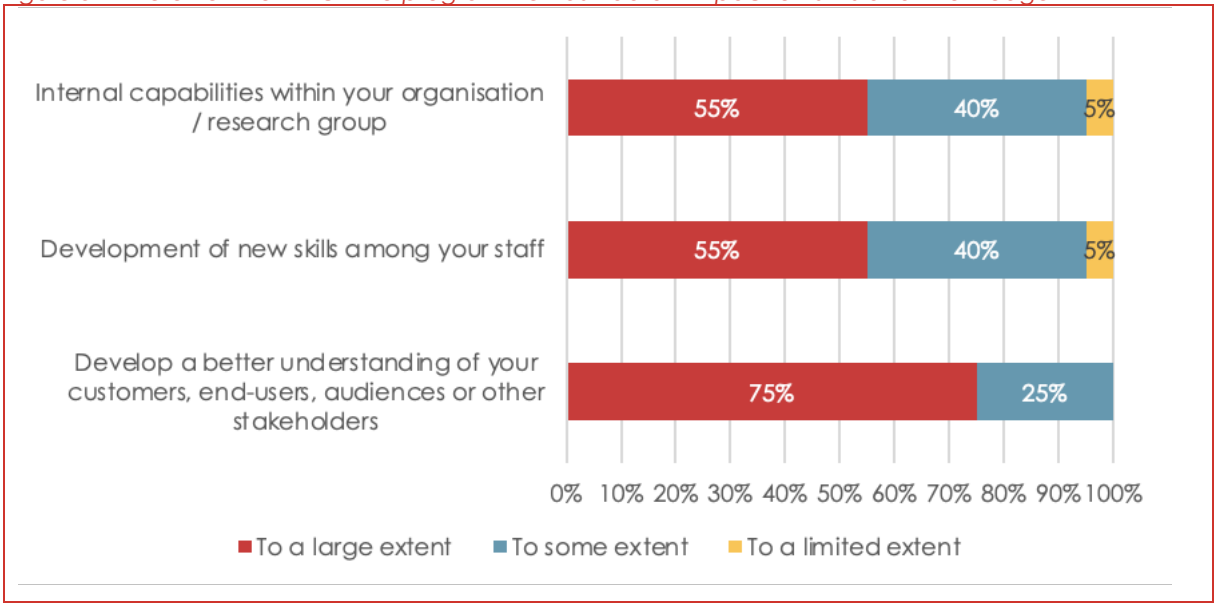
Full case study available in 0

3.2.5 Capacity building

Evidence collected from the survey shows a **good uptake of new skills and internal capabilities** developed due to participation in the programme. From the 20 participants, 75% said that they have developed a better understanding of their customers or stakeholders to a large extent, and a further 25% said this has happened to some extent.

Except for one participant, all surveyed respondents stated that their involvement in the programme has led to new skills among staff and improved internal capabilities within their organisations/research groups (with roughly half saying this has happened to a large extent).

Figure 8 The extent to which the programme has had an impact on skills and knowledge



Source: Technopolis analysis using CATI survey.

One business reported using the technical skills and capacity gained through DF2 to undertake a grant-funded virtual production project, which they say they would not have been able to do without the project.

"Setting up a pipeline, via blender, unreal, Photoshop, and all of these things… getting that right was a huge learning curve. We got a subsequent grant that allowed us to then shoot a film with virtual production to expand upon that. And those skills, you know, were critically important. I wouldn't have been able to have done that [without DF2]."

Reflecting on how DF2 has impacted the organisation's capacity for innovation, another beneficiary had this to say:

"[DF2] has been transformational because we definitely wouldn't have been able to do the project. We had the ambition to do something like this, but we really wouldn't have known where to turn, to be honest, because we're not a tech company."

Box 4 Case study summary: ALIVE

ALIVE: Avatar Learning Impact assessment for Virtual Environments

Edify, an immersive solutions company sought to explore avatar use in soft skills training and social interactions through the Unreal Meta Humans tool. Working in collaboration with the University of Glasgow, Edify used their DF2 project to further explore and deepen their understanding of a technology that was a core part of their roadmap. During their DF2 project, Edify built an app that used Unreal meta human hyper-realistic avatars which were then tested with users in a lab at the University of Glasgow, exploring perceptions of facial expressions to further their understanding of social interaction. This technology is cutting edge and the full possibilities are still under researched, with Edify noting that "many of the developers / artists hadn't used the technology before so was a learning experience". As a result, this project was valuable for both Edify and the University of Glasgow to better understand the technology, its potential and the needs of their end users.

The project also helped Edify to **better understand the technical limitations** of the technology, which in turn has **implications for their longer-term strategy**. Through the project, it became clear that the 'meta human' file sizes are too large for on-device access. As a result, whilst the company was considering migrating from the Unity to Unreal platforms prior to their project, the findings of their DF2 has triggered them to pause this approach. In addition, Edify noted that this was the first IUK project for many of the team members, so it was a "great introduction as to how these projects function".

All of the technology developed remains in the company's roadmap and they are currently in discussions with two customers to accelerate this and see how they can adapt the customers' use case to make the tech viable.

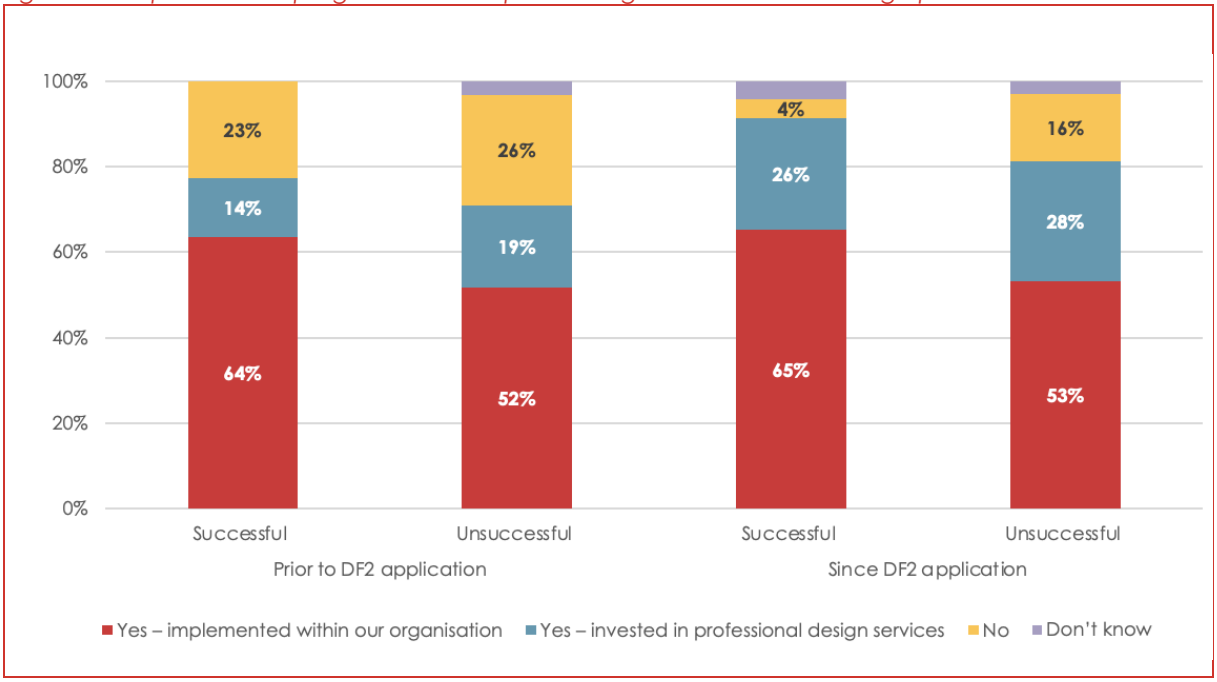
Full case study available in 0

3.2.6 *Design Methodologies*

One of the unique aspects of the DF2 programme is the requirement to **incorporate design methodologie**s into the projects' core activities. The survey found that 91% (18/20) of programme participants have implemented design processes or invested in professional design services since applying to the programme, up from 78% prior to the application. The increase in this regard has been slightly lower for unsuccessful applicants (from 71% to 81%).

Most programme participants indicated that the adoption of design processes has to a large (60%) or moderate extent (20%) improved their ability to communicate the value of their project to investors, funders or customers.

Figure 9 Impact of DF2 programme on implementing human-centred design processes



Source: Technopolis analysis using CATI survey.

There is strong evidence from the qualitative interviews that the application of human-centred design methodologies had a positive impact on both the DF2 project outcomes and the companies undertaking the projects. For example, two companies interviewed as part of this

research said they were not familiar with human-centred design thinking prior to DF2, but now describe it as fundamental to the way they approach innovation.

> ***"It really did help our company, and the freelancers in our network, learn more about human design thinking. And that's become more integrated into the business. It is something that we didn't know anything about."***
>
> ***"The whole project was a human-centred design project, which was something I was vaguely familiar with it, but it gave us an opportunity to really understand the whole Double Diamond design methodology; it really gave us very deep, rich insight, and made it much, much richer project overall."***

Two companies reported that the experience of using human-centred design methodologies had helped them to shift their focus from the technical side of their product to the user response, and that this had been an important learning curve for them.

> ***"You can be very focused on the tech. And even if the tech works perfectly, if human beings don't like the way it works, they're not going to use it. We have learned quite a lot around that in this process. And I don't know if we would have got that if we hadn't systematically gone through the process."***

There is also evidence of companies applying their experience of design methodologies to subsequent projects and problems.

> ***"I feel like we have the methodology to at least not make decisions from a kind of gut instinct perspective, which I'm very pleased about."***

However, one company noted that it can be resource intensive for micro-SMEs to introduce staff and collaborators to the language and concepts behind design methodologies, especially when already dealing with the challenge of making sure all collaborators had a common understanding of some of the technical language being used.

> ***"We are a micro SME. The smaller you get, the more time it takes to see if you have a dedicated design team that are totally up to speed with all of that, and to train all your staff on that methodology and that language."***

While there is evidence that the use of design methodologies was a key project anchor for a number of the participating companies, this was less apparent in relation to the three thematic areas. While projects did address the themes – indeed, it was a condition of funding – the qualitative research found little evidence that the thematic areas were front and centre of participating businesses minds when undertaking their projects.

Reflecting on the thematic areas, a former member of the delivery team felt that in allowing companies to say they were responding to multiple themes, as opposed to just one, may have diluted this aspect of the fund design. They also felt that some of the themes were too vague (Cross-Sector) or lost relevance over the course of the competition (Build Back Better). Future thematic areas suggested were Equity, Diversity and Inclusion alongside Net Zero.

3.2.7 *Inclusive design*

There is also qualitative evidence that the application of human-centred design methodologies has resulted in more inclusive design, even when this had not been something companies had set out to investigate through their projects.

For example, user-testing research undertaken by one beneficiary company found that their product had significant potential for improving safety and accessibility of live experiences for young adults, particularly for young women and girls, and for disabled people.

This had not been intentionally explored as part of the research, but emerged organically through the research, and has changed the way the company talks and thinks about the inclusivity of their product – to potential users as well as to investors.

> ***"Safe, easy, accessible, were not words that we used before. But they are words that we use in everything we do now."***

Another company's user research also raised questions around making their product accessible to people from all communities and backgrounds and helped them to think through how they can design experiences – and communicate them – with inclusivity at the centre. Once again, this arose organically from conversations facilitated by their DF2 project.

> ***"In order for our model to work, we need to attract audiences to interesting, weird spaces to do interesting, weird things. How do you manage expectations? There's a really big challenge here. Audiences aren't returning to traditional venues like theatres after COVID. They can also be perceived as unwelcoming spaces for minorities or people of colour so how do we put inclusion at the centre of what we're doing, when our work operates outside of these traditional venues? How do we make it both accessible and understandable?"***

Box 5 Case study summary: Nature stages

Nature stages - Ruleo & Partners

Ruleo & Partners is a micro-enterprise established in Summer 2021 to develop an XR product to encourage children to connect with nature. Ruleo, in collaboration with FAM Design, used their DF2 project to prove the viability of their early-stage app of XR activities, games, stories, and learning experiences and test it with over 70 children and parents, and learning experts, in urban and rural environments.

Ruleo had not used design methodologies prior to their DF2 project in such a structured way. The company found the design methodology useful to guide the delivery and reporting throughout the project, including understanding how to communicate the concept of the app to users during early stages of development.

The initial research and user testing enabled by the DF2 project **resulted in multiple ideas for the platform and content**, e.g., around engagement, rewards, tasks, quests, and tools. According to Ruleo, "**these wouldn't have been discovered if we had operated as a closed studio team with no consultation with the audience**". Having an early-stage prototype that has been tested by users has also been hugely beneficial when engaging in meaningful conversations with funders, partners, and collaborators about taking the project forward.

The company has also been able to access networks of groups thinking about nature connection, technology, and application in health and education settings thanks to their DF2 project.

Ruleo **will "undoubtably" continue to be led by human-centred design-thinking going forward**, focussing on Life-Centred Design principals.

Full case study available in 0

3.3 Economic

3.3.1 Turnover

The survey results indicate that DF2 programme participants have gained a larger absolute increase in the median **turnover** than non-participants (£60k vs £14k). For successful applicants, the median turnover has increased from £42,500 in the baseline (i.e. 2020/21) to £102,500 at the end of the 2022/23 financial year. Unsuccessful applicants had a lower median turnover before applying to the programme and reported a more modest increase over the same period, from £11,250 to £25,000.

According to the survey, programme participants also experienced a larger increase in the median value of **turnover derived from products and services relating to immersive content or technologies** (£47,500 vs £27,500). Programme participants reported a median of £72,500 in the financial year of 22/23, a sizeable improvement from the baseline value of £25,000.

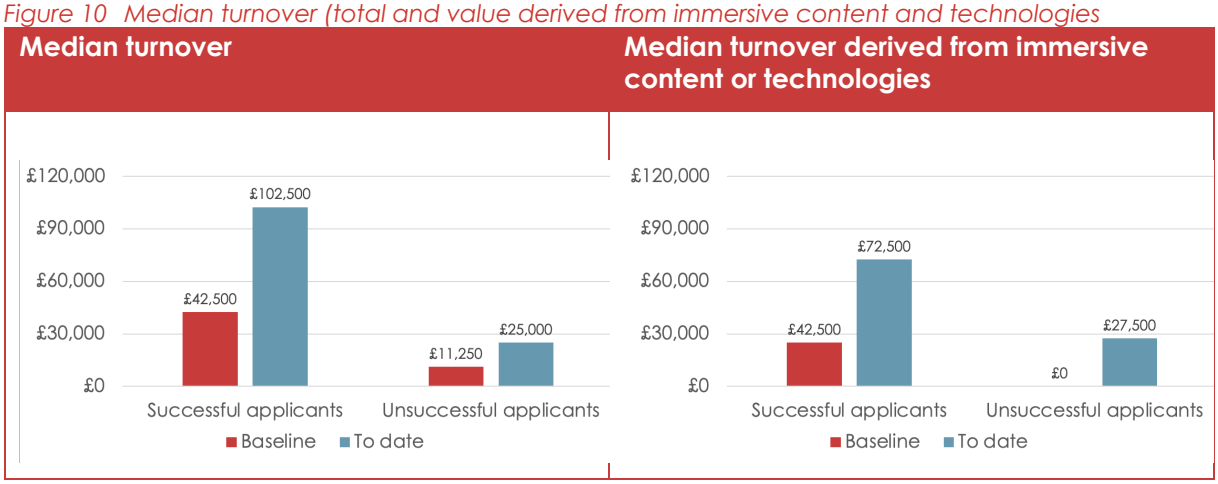
The in-depth interviews also shed a light on the ways in which the programme has supported the generation of new revenue streams. For example, one company reported that they have been able to generate revenue from the insight and industry understanding developed through their project through b2b consultancy projects and university teaching posts.

> ***"We have this digital toolkit, industry data, templates, forecasting, etc, some of which we've actually commercialised through b2b consultancy and by working with other companies. And some of it has also been commercialised through being brought in as educators for universities. So it's helped us develop a kind of b2b arm, which has been useful."***

In 2022/23, the median value of **annual spending on external suppliers for activities related to immersive content/technologies** was twice as high for successful (£20k) as unsuccessful applicants (£10k). Both groups experienced the same absolute increase of £5k since the baseline.

Note that this data corresponds to those businesses for which we have data at both baseline and 2022/23 financial year to ensure comparability. In addition, where information was provided in a band, we have calculated a mid-point to arrive to a numeric estimate.

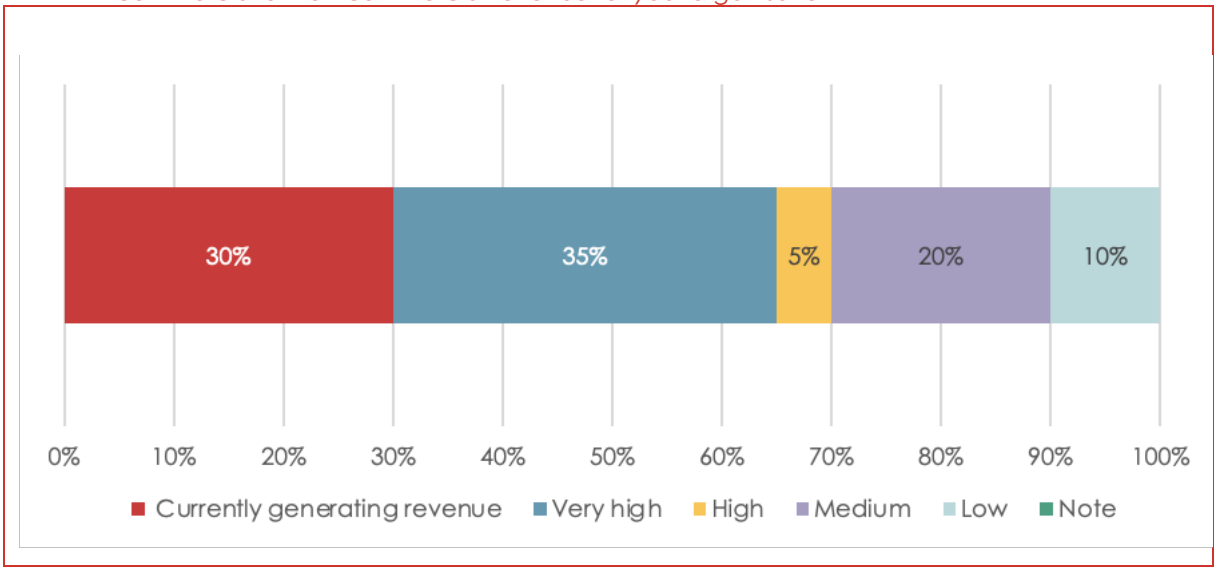
Figure 10 Median turnover (total and value derived from immersive content and technologies



Source: Technopolis analysis using CATI survey.

Survey respondents were asked to indicate the probability of generating commercial and non-commercial revenue from developments supported by their DF2 project. From the sample of 20 programme participants, 30% said that they currently generate revenue and a further 40% indicated that the probability of achieving this in the future is very high or high.

Figure 11 Probability that the development supported by DF2 project has led or will lead to new commercial or non-commercial revenue for your organisation



Source: Technopolis analysis using CATI survey.

3.3.2 *Employment*

The funding has supported strong **employment benefit** in terms of both job and income growth. Since the start of the DF2 programme, participants have hired a total of 54 full-time equivalent employees or researchers to deliver project activities (median: 2 per organisation). In 2022/23, programme participants reported a median value of 5 FTE, a significant increase from 2 FTE reported in the baseline. Over the same period, the median number for unsuccessful applicants has decreased, from 2 to 1.

The average salary of survey programme participants increased by 21% over the assessment period, from £34k to £41k. In contrast, the average salary for unsuccessful applicants decreased from £22k to £19, over the same period.

Table 9 Employment

Indicator	Successful		Unsuccessful	
	Baseline	Post-exit	Baseline	Post-exit
Number of full-time equivalent employees	2.0	5..0 ▲	2.0	1.0 ▼
Number of freelancers/ contractors (FTE) employed in immersive, businesses only	2.0	2.0 ■	2.0	1.0 ▼
Average salary of employees	£34k	£41k ▲	£22k	£ 19k ▼

Source: Technopolis analysis using CATI survey.

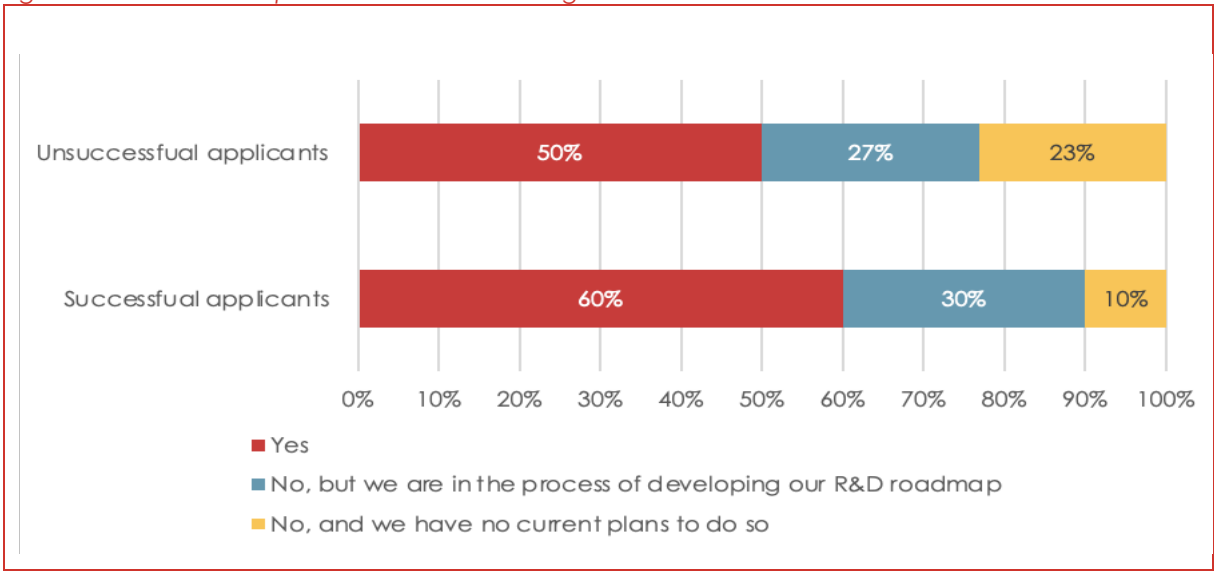
3.4 R&D spending and investment

DF2 applicants were asked if they have developed an R&D map to measure the extent to which the business has developed a clear direction for achieving their R&D goals. Having an R&D roadmap provides several benefits that makes it more likely for businesses to remain

competitive, including aligning R&D activities with the overarching business strategy, prioritising resources towards achieving specific milestones, and helping to plan for potential risks and challenges.

The survey indicates that around 60% (12/20) of programme participants have developed an **R&D roadmap for immersive technologies**, and further 30% are in the process of doing so. In comparison, from the 26 unsuccessful applicants who responded to the survey, half have developed a R&D roadmap and 27% more are in the process of developing one.

Figure 12 R&D roadmap for immersive technologies



Source: Technopolis analysis using CATI survey.

Results from the survey indicate that the programme has helped to leverage additional **investment into R&D** for creative immersive products and experiences. Successful applicants reported a median value of R&D investment in creative content of £300k, a significant increase from the baseline position of £70k. Over the same period, the median value for unsuccessful applicants has stayed the same, at £25k. This substantial increase in R&D spending positions programme participants for future TRL progression and significantly enhances their prospects for successful commercialisation of both new innovations and those specifically supported by the programme. A continued investment will help participants to navigate the remaining TRL stages and successfully bring their innovations to market.

The **sources of funding** were found to be similar for both successful and unsuccessful applicants, with roughly half of R&D investment being self-financed and further ~30% financed through grants. Successful applicants have experienced a modest increase in the share of equity and other sources of funding since the baseline.

Table 10 provides insight into the proportion of DF2 applicants' turnover that is allocated towards R&D activities. In 2022/23, the **median value of R&D investment as a share of turnover** is higher for programme participants than unsuccessful applicants (42% vs 33%) which may suggest greater commitment to innovation and willingness to invest in the development of new products/services to maintain a competitive edge in the marketplace. Compared to the baseline, the median ratio has decreased for both successful and unsuccessful applicants, but the drop has been larger for the latter group (6ppt vs 27ppt).

Table 10 R&D investment

Indicator	Successful		Unsuccessful	
	Baseline (2020/21)	Today (2022/23)	Baseline (2020/21)	Today (2022/23)

Value of R&D investment in immersive content or technologies (median)	£70k	£300k ▲	£25k	£25k ■
R&D Intensity (R&D investment as a share of turnover) (median)	48%	42% ▼	60%	33% ▼
Sources of R&D investment in immersive content or technologies (average)	Self-financed:68% Loan: 1% Equity: 0% Grant: 30% Other: 1%	Self-financed:55% Loan: 0% Equity: 3% Grant: 36% Other: 6%	Self-financed:44% Loan: 6% Equity: 14% Grant: 32% Other: 4%	Self-financed:45% Loan: 3% Equity: 8% Grant: 30% Other: 5%

Source: Technopolis analysis using CATI survey.

When queried about follow-on investment during an in-depth interview, one company said they have been successful in attracting additional funds from Creative UK to build on the work begun through DF2.

"[DF2 has increased our capacity for innovation] 100%, because that's literally what we just got funding for more of that this week from Creative UK, about £18,000 in total, which is to build upon a lot of the learnings from it."

Another company also reported that their DF2 project has increased their potential to attract investment and raised the company's profile with investors.

"Winning the Innovate grant over the course of the last year has massively changed perception of our company. As a result, there was a guy, an investor who reached out to me on LinkedIn, saying, we've been watching your progress, and we're really interested in investing in you [..] I'm just feeling in a stronger position to raise investment whereas it I just didn't have the confidence to that last year or, or the knowledge or understanding of any of that last year."

Box 6 Case study summary: CrowdSurf

Feasibility study into how to put the audience at the heart of large scale live streaming events through interactive virtual crowd technology- CrowdSurf

CrowdSurf is a start-up company based in the Northwest of England focussed on developing the CrowdSurf product: a new mobile-first live streaming platform to allow people to experience live streaming events whilst interacting with artists and members of 10,000+ crowds.

The objective of the DF2 project was to develop a market-tested specification for the CrowdSurf minimum viable product, undertaking market and user research and testing to develop the prototype. Through their project, they were able to **develop a prototype** and take their idea from TRL 2 (Feasibility) to TRL 3-4 (Proof of concept) and have since **applied for patent and design protection**.

Though not new to iterative design methodologies, their DF2 project enabled CrowdSurf team to implement these processes comprehensively, gaining more precise and scientifically-based evidence to build the platform prototype. Subsequently, they were able to **better communicate the value of their project to investors** and potential customers. The insights gathered during the research and feedback phases also led to **changes in**

CrowdSurf's business model and provided Crowdsurf with a deeper understanding of the market.

The DF2 funding has helped the company to move through a key development stage and has provided them with real momentum and with the prototype and additional insights. CrowdSurf team have **secured further private and public investment,** including an **Innovate UK Smart Grant valued at £350k**.

Full case study available in 0

However, several companies reported in qualitative interviews that they had been unable to find further investment to continue their projects. What's more, companies were then unable to apply for UKRI's Creative Catalyst programme, as receiving prior InnovateUK funding made them ineligible. This may have limited the impact of the DF2 competition, as there was not an obvious route for companies to attract follow-on investment to build on the prototypes and business models developed through their projects.

"A funded discovery period really de risks your project going forward, and it's been very useful... but we now can't get funding from Innovate, because they've shifted to the Creative Catalyst model, which means you have to be a first time beneficiary, which we're not eligible for, but there isn't any kind of follow in funding that we can apply for. So it felt a bit frustrating."

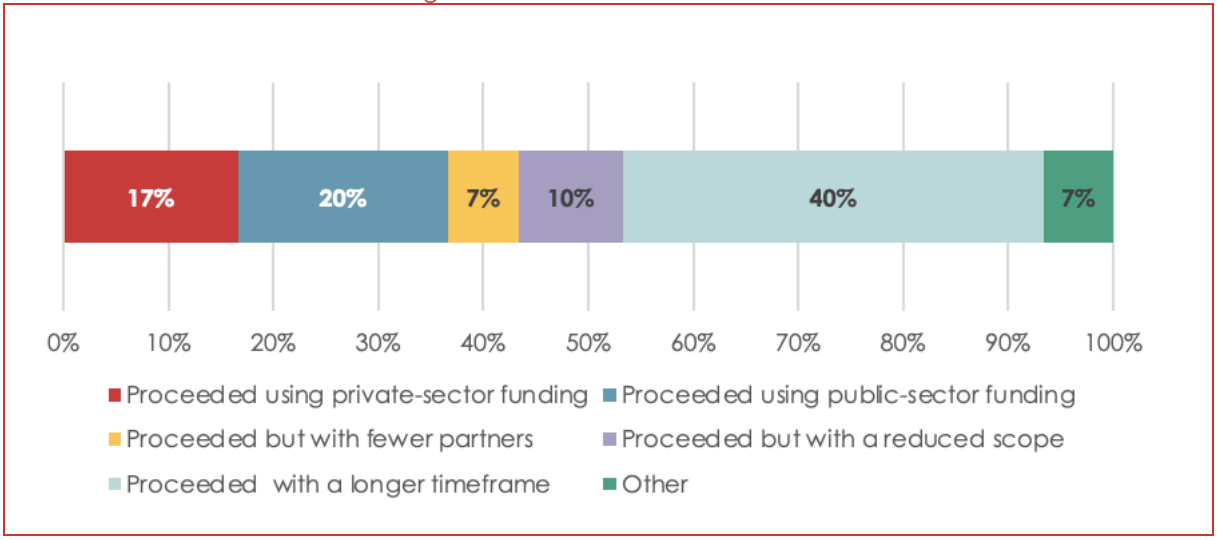
"[Someone said to me] when are you about to fall off the cliff and I didn't know what she meant. I do now. You know, it's a very hard end, isn't it? We've got to learn if this patent is worth it? Now we've got to think about entry to market … We're still not able to fully talk about it because we're not sure if it is right or not."

"At the moment, we've got this prototype software. We've invested our own reserves from a charity to develop the project since Audience of the Future gave the seed funding. But we're not ready to launch it yet. It's still underway. And we really need some more funding."

3.5 Counterfactual

Overall, 28% (8/29) of surveyed unsuccessful applicants have not proceeded with their DF2 project. From the organisations that have continued, the majority indicated that they did so with fewer partners, reduced scope, and/or longer timeframe. Eleven organisations indicated that they have continued with the help of alternative private and/or public funding.

Figure 13 Unsuccessful applicants' responses to the survey question "What has happened in the absence of the DF2 funding?"



Source: Technopolis analysis using CATI survey.

4 Conclusion

The AotF Challenge launched the DF2 funding following the success of the first Design Foundations competition, which was highlighted in some of the early evaluation of the programme. The evaluation of the two rounds of funding in the programme has revealed that both DF funding competitions have been successful in various aspects[3]. Firstly, there has been a notable progress in TRL for companies throughout both competitions, indicating the development and maturity of new products and services. Furthermore, the evaluations have shown that both rounds have resulted in the creation of new innovations with revenue streams, indicating the contribution to generating economic value. This is a remarkable result given the funding's focus on supporting early-stage projects.

In comparing the two rounds, this evaluation has uncovered additional positive outcomes reported by DF2 participants. Notably, the DF2 competition exhibits evidence of significant increase in R&D spending compared to the baseline, indicating a deeper investment in R&D activities and commitment to further refine and advance innovations.

In response to the survey, participants described the DF2 award as a 'steppingstone to a larger grant'. DF2 surveyed participants also provided positive feedback in relation to the adoption of design methodologies. By incorporating human-centered design methodologies, project participants have become better prepared to demonstrate that their R&D efforts are based on actual user insights and preferences, thereby enhancing the product's credibility and increasing investors' confidence in reaching successful outcomes. In response to the survey, one DF2 participant said:

"It was great, honestly. It kick-started the company. Without it we'd either not be trading or we'd be way further back. It gave us the space and resources to do the initial stages properly which meant when we made our first prototype, because we had done the audience research and design iterations, the prototype was further advanced than it would have been otherwise.

[3] Design Foundation 1 applicants were surveyed in Sep-Oct 2020.

That then secured us some seed investment which allowed us to match fund. It was really a key thing for us at that stage in the company. The prototype that DF2 allowed us to develop gave us the kick start that the company needed and led to external investment."

The in-depth and case study interviews with various award holders also demonstrated examples of how the funding allowed them to better communicate the value of their project to investors and potential customers. The insights and feedback gathered as part of funded projects have led to changes in businesses models and provided an opportunity to develop a deeper understanding of the market.

The adoption of design methodologies has allowed participants to deliver benefits that they would not have been able to deliver otherwise including the opportunity to design more intuitive and accessible products/services. Feedback from the interviews suggests that Equality, Diversity, and Inclusion considerations emerged organically through DF2 project research even when this had not been originally intended. The design methodologies adopted as part of DF2 projects have significant potential to improve the accessibility of live experiences for people of all communities and backgrounds, reducing the risks that segments of the populations are left out.

Appendix A Case studies

ALIVE: Avatar Learning Impact assessment for Virtual Environments

In short

The project: Facial perception testing for Unreal 'meta human' avatars

Funding received: £27,607 (70% of total project costs)

Partner organisations: University of Glasgow

Progress (at interim stage): Feasibility [TRL 1-2] to Proof of concept [TRL 3-4]

Sublime Digital Ltd (trading as Edify)

Edify, based in Glasgow and Dubai, develop immersive solutions for learning and skills training.

The project

The company sought to explore avatar use in soft skills training and social interactions through the Unreal Meta Humans tool. Edify had been interested in Unreal and 'meta humans' for some time and the DF2 competition provided the support for a research project to further their understanding of social interactions in immersive worlds.

In particular, Edify wanted to explore how increasing the realism of avatars could help to improve teaching tactics.

The company partnered with researchers from the University of Glasgow's Centre for the Study of Perceptual Experience & Sublime to bring expertise in computer science and psychology.

This collaboration was not new, as they had collaborated under a previous IUK funded project Mobius[3], however this DF2 project reinforced this relationship and enabled Edify to work more closely with specialist departments within the university.

The project combines gaming tech, virtual reality, and user generated content to create accessible, immersive, and engaging educational experiences. The project started reviewing literature on avatars and the 'uncanny valley' concept to provide a foundation for the project research.

The app was built by Edify's Chief Technical Officer using Unreal meta human hyper-realistic avatars, which were then tested in a lab in the University. The team acknowledge that the research potential in the field of avatars is vast but needed to narrow the scope to make it feasible within the project constraints so chose to focus on perceptions of facial expressions.

Collaboration and Design Methodologies

Given the criticality of the user experience to their product offerings more generally, Edify had experience of using human-centred design principles prior to their DF2. The team said that human-centred design principles were absolutely aligned with the project aims, as the value proposition for the metahuman subject area is centred around the practicalities of usability.

Despite this prior experience of design methodologies, Edify also noted that "commercial pressures often dictate that 'proper' human centred research and analysis on a subject isn't possible, and working iteratively through an experimental design and feedback process on this process was a welcome opportunity."

For Edify, the project was evidence that research can both be done to a high standard and be done quickly. They regard the project as validation of their longstanding relationship with the University of Glasgow.

The project did, however, encounter some challenges with the time it took to get ethics approval for the research, and while they did conduct testing as planned, the team feel the project would have benefitted from a slightly longer project timeline.

From the perspective of academic researchers, it was exciting to see how their research could be applied by companies and have immediate impact.

This relationship has continued to grow since the end of the project. Edify have recently been announced as a preferred supplier for the University's Museums in the Metaverse project which will create a two-sided Extended Reality (XR) Culture and Heritage platform.

Results

The technology used during the project – Unreal engine meta humans – is cutting edge with little research conducted into the possibilities, with Edify noting that "many of the developers / artists hadn't used the technology before so it was a learning experience".

Through testing of the technology, Edify say they have opened up new potential avenues for immersive human interaction and as a result have a much better understanding of their end users.

In addition, Edify noted that this was the first IUK project for many of the team members, so it was a "great introduction as to how these projects function". They will be able to apply these learnings to the Museums in the Metaverse project, which will follow a similar structure to the DF2 project.

The project also helped Edify to better understand the limitations of their concept from a technical perspective. One challenge that arose was the file size of the 'meta humans', which is too large for on-device access and limits some of the immediate possibilities for this tech.

This experience has had a significant impact on the organisation's strategy. Prior to the project, Edify were considering migrating the company's platform from Unity to Unreal, however the bandwidth needed to host the meta humans has led to the company pausing this approach for the time being as they do not feel it is feasible.

Since the project finished, the advent of AI 'deepfake' technologies has also changed the landscape, lowering the threshold to achieving usable realistic digital humans. While the company think that Meta humans will surpass this technology, in the short term they believe there are better ways to achieve a similar goal in relation to some of the use cases the project was exploring.

The learnings from the project have been shared with the industry through blogs and white papers which have led to conversations with major players such as Meta.

Edify feel that the academic rigour of the research has enabled them to talk coherently and credibly with potential partners, as well as the confidence to know that when the product goes to market, it will work. The demonstrator built through the project can be used with clients in order to position a future narrative and secure engagement on the topic.

While further research is required, the project has given the company the foundations to explore new services and/or products within the Edify platform with end users.

The project enabled Edify to take a concept from their company's roadmap and explore it in more detail with academic rigour.

In the longer term, Edify expect this to lead to new and improved production methods, and products and services in the future. In terms of the future use of the product developed, Edify see a key use case as 'soft skills' training such as interview training or experiences which allow the user to gain greater empathy through different perspectives.

All of the technology developed remains in the company's roadmap and they are currently in discussions with two customers to accelerate this and see how they can adapt the customers' use case to make the tech viable.

Ultimately, the project has helped Edify to de-risk bleeding edge R&D and equipped them to educate customers and discuss requests for this tech in the context of the limitations found.

Feasibility study in how to put the audience at the heart of large scale live streaming events through interactive virtual crowd technology

In short

The project: Feasibility study in how to place the audience at the heart of large scale live streaming events through interactive virtual crowd technology

Funding received: £34,961 (70% of total project costs)

Partner organisations: CrowdSurf Limited

Progress (at interim stage): Feasibility [TRL 2] to Proof of concept [TRL 3-4]

Progress (at final stage): Commercialisation [TRL 9]

DF2 Thematic area: Build Back Better

CrowdSurf

The CrowdSurf project was led by CrowdSurf Limted, a start-up based in the Northwest of England and founded in 2021 specifically to develop the CrowdSurf product. Currently in its seed phase, the uses its innovations in real-time media distribution to create shared expereiences for large scale live events. The DF2 project provided the funding required to develop an audience-facing prototype and the research insights required to improve it.

The project

Live events are a social experience, where one's experience also includes connecting with others, interacting and a sense of togetherness. In recent years, live event streaming platforms have seen a substantial rise in the market due to higher demand, a trend accelerated by the COVID-19 pandemic and associated lockdowns. However, the available technology is not currently fit for large scale entertainment as existing platforms have either a limited number of attendees with limited interaction features, or a large number of attendees with little to no interaction.

The idea for the CrowdSurf project and company started when the team saw an opportunity in the market of virtual events, particularly in the entertainment segment of live streaming events, to create "an innovative platform that puts the audience at the heart of the experience though interactive virtual crowd technology". The new-born company and new product, CrowdSurf, is a mobile-first live streaming platform that will allow people to experience live streaming events together, interacting with the artists and members of 100,00+ crowds. This product could offer a better immersive experience for live streaming and make large shared

experiences possible by creating a meaningful alternative to real events while also improving accessibility and reducing environmental impacts and costs.

The objective of the DF2 project was to develop a market-tested specification for the CrowdSurf minimum viable product (MVP). During the 3 month project, CrowdSurf carried out market and user research, developed principles and assumptions, explored hypotheses tested designs with users and built a prototype to present to investors.

The new product improved the state-of-the-art of live streaming events thanks to the development, integration, and exploration of three innovations:

- Real-time unlimited crowd rendering
- Low-latency, high-quality artist interaction
- Real-time crowd audio mixing

Design Methodologies

In terms of design methodologies, CrowdSurf implemented a human centred design process throughout their market and user research, technology development and testing. The team recruited a cognitive psychologist to design and conduct the user research which was then used to inform each subsequent iteration of the prototype.

In regard to the user research, the team analysed three stakeholder groups: live event audience (end-users); paying customers (brand and rights-holders); and production stakeholder (managers, engineers, and directors). The user research was undertaken in parallel with the iterative design of the prototype.

The team performed comprehensive hypothesis testing through iterative cycles of one-to-one interviews and rapid prototyping, drawing on smoke test assets and coded front-end / back-end prototypes. The team formulated hypotheses on the commercial and practical functionality of the prototype, prioritised them and based on the prioritisation, interview guides were designed to test the hypotheses. Collecting viewer insights over three cycles of one-to-one interviews, different prototypes were tested, starting from mock ups of what the platform would look like ("smoke test") until later stages when the prototype was tested using the audience's smartphones. The team iterated and made changes to the MVP based on feedback.

Through the application of these methods, the CrowdSurf team developed a better understanding of their customers, audiences, and other stakeholders. Based on research findings and user insights, the team was able to include additions to the MVP specification and ultimately achieve a better MVP.

Staff of CrowdSurf had used iterative design methodologies in the past, but the DF2 funding enabled the team to implement these processes comprehensively, gaining more precise and scientifically-based evidence to build the platform prototype. In addition, applying comprehensive design processes at this relatively early stage improved the company's ability to communicate the value of their project to investors and potential customers.

Results

According to CrowdSurf, the project was able to achieve more than originally expected. As a result of the DF2 project, CrowdSurf developed a market-tested specification for their MVP and developed a working prototype. The funding allowed the team to test the innovative technology through various iterations, developing the design at a faster pace and on a bigger scale than expected, allowing the team to prepare for market entry more quickly and with higher level of confidence in the product. As a result, the prototype moved from TRL 2 (Feasibility) to TRL 3-4 (Proof of concept).

In addition, the project created a path to multichannel revenue streams that support live venues and performance spaces, as well as, artists by creating new hybrid revenue possibilites

and a way to give virtual audiences a meaningful shared experience. Finally, with consumer consent, the new technology provides enhanced audience insights and segmentation at a level not currently possible in the live streaming industry.

The team has applied for patent and design protection for the technologies and UX developed for the CrowdSurf platform and its prototype has been used to secure private investment.

Internally, the project acted as a catalyst to implement processes systems that will continue to be used beyond the project. This includes new risk management and time tracking processes, as well as improvements to their project management processes.

In addition, the project also contributed to the retention and creation of jobs: a world-class user researcher and cognitive scientist who was hired during the project will continue to work with the organisation beyond the project.

The project team has also developed their research and analytical skills as a result of the project. The team has also learned how to implement iterative design in a more efficient way thanks to the disciplined structure of the work-packages, deliverables, and monitoring of progress.

The insights gathered during the research and feedback phases also led to changes in CrowdSurf's business model and provided CrowdSurf with a deeper understanding of the market.

In consultation, interviewees expressed how having the opportunity to speak and interact with a diverse range of stakeholders (artist management, directors, engineer, and potential customers) in a context that was not a direct commercial pitch was useful for relationship building. For example, the customer interviews were an opportunity to introduce the platform to potential clients, while the engineer interviews provided valuable input to improve future features. All these interactions and new channels of communication have opened up possibilities for new collaborations and partnerships for CrowdSurf.

Next steps

The DF2 funding has enabled the company to move through a key development stage and has provided them with real momentum. The audience-facing prototype has helped the CrowdSurf team to secure further investment. As David Agrawal, CTO of CrowdSurf, put it:

> *"It was really a key thing for us at that stage in the company. The prototype that DF2 allowed us to develop gave us the kick start that the company needed and led to external investment."*

The next steps are to build the MVP and to take it to the market by starting to test the platform with test users at events in Q4 2022,followed by closed beta trails with early adopters right-holders. Since the DF2 project, CrowdSurf has secured further private investment and an Innovate UK Smart Grant valued at £349k, which has funded core R&D and the recruitment of a highly specialised engineering team.[4] CrowdSurf's focus is now on refining the user experience through in-market testing ahead of scaling up.

References and sources of information

- Interview with David Agrawal, CTO at CrowdSurf
- CrowdSurf Project Completion Form (April 2022)
- Progress report (31/03/22)
- DF2 Post-Project Form (May 2022)

[4] https://gtr.ukri.org/projects?ref=10021830#

- 10021829 – CrowdSurf, Audience of the Future, Close-out presentation

Volume – Sage Gateshead/North Music Trust

In short

The project: Sage Gateshead/North Music Trust's project 'Volume' explored and tested the potential for volumetrically captured augmented reality (AR) experiences to engage new and diverse audiences for immersive technologies.

Funding received: £29,606 (60% of total project costs)

Partner organisations: Sage Gateshead/North Music Trust and Dimension Studio

Progress (at interim stage): TRL 1, prototype to Proof of concept [TRL 3-4]

Progress (at final stage): Demonstration in real environment [TRL 7-8]

DF2 Thematic area: Build Back Better

Participants

The 4-month project 'Volume' involved three partner organisations: Sage Gateshead/North Music Trust (SG/NMT), Dimension Studio, and Proto. The charity SG/NMT, the project lead, is a large-scale performing arts venue based in Gateshead (Northeast of England), home to the Royal Northern Sinfonia. Dimension Studio are one of the leading UK companies for volumetric content and virtual production. Based in London, they were involved in every aspect around the production of the prototype. SG/NMT was also supported by Proto in the development and delivery of the market research. Managed by Gateshead Council, Proto is a digital production facility and is part of the Digital Catapult North East Tees Valley (NETV) network.

The project

The 'Volume' project was prompted by the 'Audience of the Future' report, The Immersive Audience Journey, which stated the importance of placing audiences at the centre of creative content.[5] According to the report, understanding target audiences is key to success, especially as "*producers are often so focused on creating the experience while audience considerations are introduced late in the process*."[6]

The cultural sector (specifically live performance) has been heavily impacted by the COVID-19 pandemic and by Brexit, motivating companies to explore new channels for content production in order to identify new markets and engage new audiences. As a result of the pandemic, there is a greater acceptance of virtual content as more work is done remotely and working across the globe is possible without the need for physical presence. This has contributed to generate momentum around immersive technology innovations.

For SG/NMT in particular, **'Volume' was an opportunity to respond to the sector's disruption** through experimentation in high quality immersive experiences, improving their capacity in relation to the production of virtual content as well as testing a viable path to reach new audiences. The technical partner, Dimension Studio, saw the project as an opportunity to

[5] https://audienceofthefuture.live/wp-content/uploads/2020/07/Audience-of-the-Future_The-Immersive-Journey-Report_July-2020.pdf

[6] Jarvinen, A. (2020) https://audienceofthefuture.live/wp-content/uploads/2020/07/Audience-of-the-Future_The-Immersive-Journey-Report_July-2020.pdf

iterate and test rendering of musical instruments in the volumetric space, an area where innovation is required to support more realistic experiences, and ultimately contribute to the creation of a richer virtual experience.

The objectives of 'Volume' were to create a feedback loop involving the audience in shaping future content as well as improving innovation capacity and foster the conditions under which AR experiences can happen at scale. 'Volume' aimed to:

- Gain additional understanding of the target audience
- Work with audience insights and then embed them into projects
- Explore alternative ways to engage new audiences
- Evaluate the potential of immersive experiences to reach wider audiences

The activities undertaken as part of the project revolved around the application of volumetric capture technology in the context of classical music. As part of the project innovative immersive content was produced by capturing a classical musician playing the cello. This content was then tested with audiences, who provided feedback by responding to two surveys about their experience and the potential of deploying immersive experiences at a larger scale.

Collaboration and Design Methodologies

The **design methodologies** used in the project include prototyping, user testing and a user centric approach informed by an in-depth market research. The collection of feedback from the audience was an opportunity to use new methodologies. The survey design was based on the market research which was conducted also using Nesta[7] and i2 media research[8] methodologies. The surveys collected demographic data, quality of life metrics and aimed at understanding perceptions of cultural value, expectations, repeatability, and users' willingness to pay for such experiences.

The project's rationale of entertaining audiences in a different space than the venue was not a new area of application for the project's lead and partners. SG/NMT had worked and experimented with digital content in the past, in particular in the area of streaming. Similarly, Dimension Studio had existing experience with volumetric capture. However, the project has been a catalyst for SG/NMT and Dimension to approach new areas with confidence and find innovative solutions to achieve a richer performance that mirrors what is happening in the live arena. The project has also been a good opportunity for both organisations to improve their abilities in the context of technological innovation and immersive experiences.

Results

'Volume' achieved results on various levels, and it acted as a catalyst for the partners involved.

On the technical side, the project presented some challenges because capturing reflective objects is inevitably difficult with the technology and instruments employed. The cello as an instrument is very reflective, with a high level of details to capture (e.g., bow of the cello, bow strings) and, as it covers the musician's body, it is predisposed for occlusion, a major problem in volumetric capture.

However, these challenges turned out to be an opportunity for technological innovation as well as innovation in content production. Thanks to the testing and production of immersive content, Dimension Studio had the opportunity to refine and develop one of their pre-existing post-production tools; in an effort to overcome the challenges in capturing reflective objects, Dimension found technological solutions that resulted in an improved production process

[7] https://www.nesta.org.uk/about-us/

[8] https://www.i2mediaresearch.com/#intro

called "light baking", which allows a higher quality in volumetric capture, maintaining a higher level of fidelity to movements and the real object.

The innovation had a direct positive impact for Dimension as it is being integrated into all the company's projects in the area of volumetric capture and distributed as a usable tool for future projects. It is an improved product that the company can add to their repertoire of assets to produce an experience that looks and feels as real as possible. Dimension stated that the light baking process can serve any prop that needs to be built as a computer-generated asset, therefore expanding its possible application into other industries such as web, AR, VR, broadcast, and film.

In terms of **skills and capabilities**, as a result of the application of a user-centric approach, the SG/NMT team strengthened their relationship with their audience and gained in-depth insights from their audience around immersive experiences and use of technology. The project also generated new information on the optimal price point for large scale experiences, which will be a helpful benchmark for future funding or commissioning of immersive content projects.

It was also noted by SG/NMT that the project provided the organisation with more knowledge around the particular technology of volumetric capture, including what it entails, its potential and limitations. Finally, as part of this project SG/NMT also learned how to develop immersive experiences in partnership. The collaborations with Dimension and Proto allowed SG/NMT to grow as a company through knowledge exchange.

SG/NMT stated that over a short period of four months, there was not enough time to iterate or scale the experience based on participants' feedback, but they confirmed that audience feedback will inform implementation of future projects: by collecting audience insights more often, projects will go through more cycles of feedback which will inform potential changes.

With regard to **organisational strategy**, SG/NMT shared in consultation that their biggest learning was the improved understanding of the market. This was defined as "*an immediate impact of the project*" as it allowed the organisation to make evidence-based decisions. Having previously commissioned virtual reality (VR) experiences, for SG/NMT applying research and production methodologies first-hand was a new experience that significantly contributed to the development of the inhouse team skills on how to conduct in-depth market research and virtual content production. This resulted in higher levels of confidence to push the company ahead in testing and creating more immersive experiences in the cultural sector as well as the possibility to reflect on the strategy and plan for the long term to produce experiences at scale.

The internal upskilling at SG/NMT **generated new and improved working processes** within the organisation which are evidence of organisational change. Consultees noted that it is now easier for the team to understand skill needs and requirements for innovation, leading to a fuller visualisation of the organisation's strategic future. SG/NMT had not implemented human-centred design processes prior to the project, but due to the project expect to do so in future. 'Volume' also showed SG/NMT the value of market research within their everyday programming as well as how its application on other areas of their work, for example digital, where market research approaches could be beneficial.

Next steps

Thanks to the DF2 project, new partnership opportunities were generated. SG/NMT also plan to disseminate the project's findings with a network of cultural organisations as well as higher education institutes to build relationships, share knowledge, and create connections in this area, especially to align with the efforts of ImmexCity which is a programme that is developing a place-based approach to support the immersive sector in the Northeast area. Looking for the right partnerships will be a key element as SG/NMT also intends to explore immersive experiences at scale, repeating the R&D approach used in 'Volume'. In sight there is also a

major re-branding for the 20th anniversary of the organisation, with a new chapter focused on digital.

References and sources of information

- Interview with Adam Kent (Head of innovation) at Sage Gateshead/North Music Trust
- Interview with Rachel Williams (Head of Digital) at Sage Gateshead/North Music Trust
- Interview with Yush Kalia (Sales and Marketing Director) and Adam Smith (Head of Production) at Dimension studio
- DF2 Post-Project Form (May 2022)

Nature stages – Ruleo & Partners

In short

The project: An immersive app that connects children to nature through play and learning

Funding received: £ 34,983 (70% of total project costs)

Partner organisations: FAM Design

Ruleo & Partners is a micro-enterprise established by George Simons in summer 2021. George set up the company following his participation in the Audience of the Future Immersive Performance Demonstrator with the ambition of testing a product within the immersive space.

The project

George credits the learning and insight he gained through his participation in AotF as the catalyst for him to apply for further the Design Foundations 2. He applied in partnership with subcontractors he had been working with through the initial AotF project.

The project responded to all three thematic areas (Build Back Better, Cross Sector and Net Zero) and aims to validate tech as a way to connect children with nature. Ruleo developed an early-stage prototype of an immersive app that engages children with the natural world through play and learning. It features creative activities, games, stories and learning experiences with augmented reality (AR).

The prototype was tested with children, adults and learning experts. The education tech sector was a new area for Ruleo, although founder George has personal experience in education through family.

The product was initially targeted towards schools. Despite positive responses from schools towards the concept, as the project progressed it became clear that this was not a viable option. This was because the app is designed to be used outdoors, and since the pandemic many schools said they had too many competing demands to be able to take the pupils outside to engage with the product.

Collaboration and Design Methodologies

Ruleo had been aware of design methodologies – especially human-centred design process – but had not used them in such a structured way prior to the project.

The company found the design methodology a useful direction to guide the delivery and reporting, especially the development of sacrificial concepts at the start of the project. These were a useful tool for understanding how to communicate the concept of the app to users early on.

'I'm reaping the benefits now of having had users and being able to go through all their responses'

Since finishing the project, Ruleo have continued to collaborate with their design partners FAM, who they worked with for the first time on their Design Foundations project. They have worked together on a follow-up Innovate UK project, this time with FAM as the lead partners and Ruleo as project managers.

This project is focused on life-centred design processes, which has similar principles to human-centred design but looking at all forms of life. Ruleo have been able to apply what they learned through the Design Foundations project to this work. The company have found the emphasis on life-centred design to be particularly well-aligned with the company's focus on nature and connection.

While the design methodologies have been useful frameworks, in both cases Ruleo found their rigid structure to be time-consuming and would have preferred a little more flexibility.

What has been achieved by the project?

Following the DF2 project, during which Ruleo were able to develop a minimum viable product, the company have been able to join conversations and networks of groups thinking about nature connection, technology, and application in health and education settings.

This includes ongoing conversations with researchers at zthe University of Derby, environmental organisations and other partners about the need to prove the need for nature connection. The project has also led to other commercial opportunities for Ruleo, such as AR consultancy projects.

While Ruleo just missed out on a second round of funding from Innovate UK to take the project forward, the prototype developed over the course has helped the company to raise its profile within the sectors the product is targeting.

I'm able to have serious conversations with a range of stakeholders with an MVP and there are positioning and business opportunities that come from that – whether it is developing that product or working in that space.

References and sources of information

- Interview with George Simons, Founder (May 2022 and April 2023).
- Monitoring Feedback

Teaching the next generation about sustainability through Mixed Reality story based play

In short

The project:

Funding received: £ 50,936 (70% of total project costs)

Partner organisations:

Progress (at interim stage): Feasibility [TRL 1-2] to Proof of concept [TRL 3-4]

Thematic are: Net Zero

Filament P.D.

Filament P.D. is a product design agency with speciality in connected hardware. They work across sectors in wearable healthcare, digital wellbeing, circular economy and increasingly education and mixed reality.

The project

Prior to their DF2 project, Filament had developed IP that used mixed physical-digital play to teach children about developing good financial habits and educate them about the value of money in a cashless society. Filament felt there was scope to expand this model to address other habit-based learning, such as healthy-eating and environmental sustainability. They applied to the Design Foundations 2 competition as they were looking for an opportunity to explore this further. The objective of Filament's DF2 project was to test and iterate this IP based on user and stakeholder feedback.

Th initial concept was a physical toy for children to scan packaging as they were recycling and gain virtual points. These points would then allow them to upscale virtual avatars and digital players. Filament used their DF2 project to consider both how users would interact with the technology and the potential business models and propositions for the future. These ranged from marketing to supermarkets and packaging suppliers to potential government and community clients.

Filament undertook design sprints with children and parents, and with commercial partners, and utilised a range of methodologies (interviews, workshops, user profiles etc.) to refine their understanding and concepts from a value and usability point of view but assess commercial potential at the same time. As a result, developing a significantly stronger understanding of their users and commercial stakeholders.

The second strand of the project, which the company refer to as 'Window to the World' looked at cardboard packaging as way into immersive learning experiences about the different environments and materials packaging and products originate from.

Collaboration and Design Methodologies

As a product design agency, Filament had extensive experience in implementing design methodologies prior to their DF2 projects, though their prior design work was often coloured by their clients' brief and assumptions.

Through their DF2 project they were able to test their initial assumption and engage users in early-stage propositions, which allowed the company to engage users to test the initial assumptions of their idea to better inform their use of the technology, users and commercial offering. As a result, Filament felt they were able to produce stronger product concepts. In future, Filament will seek to engage potential commercial partners in the ideas stage of the project and secure their buy in to the project from the outset.

Results

As a result of their user testing, Filament developed three new models for how their concept could be developed and commercialised, including i) an instore intervention to be used by

supermarkets or large retailer campaigns, to help users make better purchasing decisions, ii) an 'at home' intervention that didn't require a separate physical product, and iii) a community-based intervention that would require additional public funding.

Though the stakeholder engagement also supported by the DF2 project, Filament found that parents and supermarkets were worried an in-store intervention could cause too much disruption on the shopping floor. The exception to this was a major furniture retailer whose unique shop floor journey (one-way system) and strategic own sustainability goals could align well with such an intervention.

Thanks to their DF2 project, Filament PB were able to develop new knowledge understanding of MR technology, including what it possible, and how to generate quick concepts and virtual prototypes to test these concepts with users.

The team also reported improvements to their programme management skills and budgeting for a project of this nature.

Next steps

For Filament, the next steps for this concept will be to find AR development partners to further develop these concepts to trail or commercialisation.

Filament are also seeking further funding from commercial partners to take the next step with their technology to include launching a trial. Conversations are ongoing between the furniture retailer and Filament about a potential trial in a UK store.

Filament have already identified further use cases for the MR concepts they have developed and are already starting to have conversations with potential clients. They are particularly interested in the potential for the Window to the World model to educate general consumers about the origin of products and see potential use cases across single-ingredient industries such as the coffee-industry. They are also planning to explore potential applications of the technology for companies which operate with a weekly and/or regular postage subscription model, such as 'Hello Fresh' weekly meal boxes as a different way for these companies to communicate with their consumer base.

References and sources of information

- Interview with Craig Lynn, Filament PD Ltd.
- Project Completion Form
- DF Post-project form
- https://www.filamentpd.com/

Distributed Stitches - Design Research for Custom-fit On-Demand Clothing Microfactories

In short

The project: Micro-factory start-up which produces on-demand manufacture of customised clothing

Funding received: £39,000 (71% of total project costs)

Progress (at interim stage): [TLR 3] Specifying and developing an experimental Proof of Concept (PoC) to [TLR 4] PoC demonstrated in test site/initial evaluation of costs and efficiency produced

Pattern Project Ltd

Pattern Project is a South London 'micro-factory' which facilitates clean, urban and local manufacturing of clothing. The company was founded by Shruti Grover and Simon Johnson, who also run design consultancy Hetco, in April 2020 after they were awarded an Innovate UK Smart Grant.

The project

The Distributed Stitches project came about when the company were looking for further funding following their initial Smart Grant. The founders' background in design meant they understood what the Design Foundations competition was trying to achieve.

The company's long-term vision is to replace fast-fashion with clean-energy driven, on-demand micro-factories on every high-streets. To do this, they have developed proprietary machinery and a patent-pending process to manufacture customised clothing.

For the first part of their DF2 project, Pattern Project undertook user research to understand the main problems that consumers experience with the fit of their clothes. They then developed an algorithm which would be able to instantly design a custom-fit skirt. This was accompanied by an in-store 'wrap-around' experience to further understand different issues relating to fit. These issues were documented in a framework.

In addition to user research, the company wanted to understand whether an in-store retail model would make sense for Pattern Project and what this could look like. They created a pop-up store in the final stage of the project to prototype the in-store on demand manufacturing model which the company called the micro-factory. This was the first time the company has demonstrated the technology in a public setting.

Pattern Project invited six designers into the live production space and invited people to come and selected which garments and which fabrics they wanted from a total of more than 6,000 options in terms of the different combinations on offer. Garments were made from deadstock fabric sources from Italy and France. The company were able test the creation of 60 new garments through the pop-up.

Design Methodologies

The company's other business – a human-centred design consultancy – meant that they were very familiar with the design methodologies encouraged through the Design Foundations competition.

The project's human-centred design methodology generated new ideas from the research participants, two of which Pattern Project plan to take forward in future. These are free sewing exercises to be offered in store and workshops to make the store more of a community hub.

Results and next steps

As a result of the project, Pattern Project have been able to determine the viability, financial model and resources needed to have a physical presence on the high street. Their DF2 project enabled the company to test their existing algorithm at a scale they could not achieved through their own means. As a result, they have a clearer roadmap for the improvements and

developments necessary and the confidence to take it to market. To support this, the company are now looking to further develop the technological algorithms that are needed to support faster production.

The project also revealed high levels of interest in Pattern Project from small designers and brands who were interested in small production runs for their designs. The high levels of interest from other businesses was not expected, and as a result the company are planning to explore an alternative business model based on B2B sales further, potentially including licensing the technology. The interest from other business in the technology has also resulted in two new collaborations with external designer studios, with the resulting products to be released in the Summer of 2022.

Towards the end of their Audience of the Future project, Pattern Project were awarded a *Designing London's Recovery* grant from the Mayor of London, which they will use to build on their Audience of the Future project and develop these technological processes.

The company say they have significantly developed their understanding of their customers and customers' needs through the project, which will inform the development of new working processes. This was partially achieved through the project's Instagram campaign, which received good levels of engagement from potential customers. This too has been a learning for Pattern Project about the way they can engage their customer-base with their vision through social media, ultimately leading to better products and increased sales.

The company are planning on seeking further funding in future, although they acknowledge that it is challenging providing match-funding for grants through their design consultancy, as this adds pressure in terms of resource, capacity and time.

References and sources of information

- Interview with Shruti Grover, Pattern Project Ltd.
- Project Completion Form
- DF2 Post-project form
- https://www.pattern-project.com/
- https://www.instagram.com/patternprojectuk/?hl=en

Appendix B Indicator tables

The numbering of the outputs, outcomes, and impacts corresponds to the numbering used in the indicator framework for the AotF evaluation and is therefore not consecutive. This is to facilitate reading across the evaluation frameworks and subsequent reports for both the Audience of the Future Programme and the Design Foundations 2 evaluation.

Indicators shaded in blue are those that are new additions to the indicator framework, to reflect the information captured in the Project Completion Forms. Indicators shaded in yellow are those that are specific to the Design Foundations 2 evaluation.

Output indicators

Table 11 Output indicators

Output	**Indicator** [B] – Baselined [C] – Counterfactual	**Data Source**	**Indicator**	
			Interim	**Final**
Output 1: Leverage R&D Investment	£ match investment into project activity and source (private, public)	Programme data	£484,864	
Output 2: New or enhanced partnerships	Number of new partnerships for participating enterprises, organisations, and researchers	Survey		104
	% agree/strongly agree programme led to enhanced partnerships	Survey		94%
	Number of partners by 'types'	Survey		84% micro 44% SMEs 24%Large 61% Academia 29% charity or public sector
	Number of partnerships including cross sectoral, business/academic, across large/small businesses	Programme data	Six collaborative projects involving 12 partners. 2/6 collaborations between industry/academia, 2/6 collaborations	

			between Micro or small company and Medium sized company.	
	Examples of impact on partnerships	PCF, DF2 Post-Project Form	See Section 3.1 and case studies on Volume 0 and ALIVE **Error! Reference source not found.**	
		Interviews, Case Studies		
Output 3: New or improved working processes/production methodologies	% of organisations who expect to introduce a new process as a result of the project (within a year or in 1-3 years)	PCF	60%	
	% of organisations reporting new production methods for immersive content	Survey		65%
	% of organisations reporting improved production methods for immersive content	Survey		68%
	Examples of new or improved production methods for immersive content	Interviews, Case Studies, Survey	See Section 3.2	See Section 3.2
		DF2 Post-Project Form		
	Number of audience-facing prototypes or pilots	Survey		23
	% of organisations reporting new or improved working processes related to immersive content	Survey		74% new 83% improved
	Examples of new or improved working processes within participant organisations	Interviews, Case Studies, Survey	See Section 3.2 and Case study on Nature Stages **Error! Reference source not found.**	
		DF2 Post-Project Form		
Output 4: New or improved immersive content, products and services	% of organisations who expect to introduce a new product as a result of the project (within a year or in 1-3 years)	PCF	97%	
	% of organisations who expect to introduce a new service as a result of the project (within a year or in 1-3 years)	PCF	80%	
	% of organisations reporting new creative immersive product	Survey		75%
	% of organisations reporting new creative immersive service	Survey		50%

	% of organisations reporting improved content, product or service	Survey		45% product 35% service
	[B] [C] % of organisations who implemented design processes (prior to programme and following programme)	DF2 Post-Project Form	74%	
	% of organisations reporting improved knowledge / understanding of design processes (e.g., Double Diamond Method)	DF2 Post-Project Form	92%	
	% of organisations indicating they expect to incorporate design processes into their future activities	DF2 Post-Project Form	100%	
	Examples of new or improved creative immersive products, services	Case Studies DF2 Post-Project Form	See Section 3.2 and case studies 0	
Output 5: New business models trialled/tested (including pricing) and evidence of commercial viability	% of organisations which indicate they have trialled/tested new business model in the last 2 years	Survey		65%
	Examples of organisations (including spin outs) developing new business models.	Interviews, Case Studies		
Output 6: New knowledge related to engagement data/profiles	Examples of enterprises and organisations generating new information about users and audience	Interviews, Case Studies	See Section 3.2	
	% of organisations which indicate they have generated new ideas or identified new opportunities due to design processes	DF2 Post-Project Form	85%	
Output 8: People directly employed by projects	Number of people employed by organisations, universities and enterprises engaged with programme to deliver project activity	Survey		54 FTE
	Number of FTE jobs retained during the project due to programme	PCF	Mean = 3 Median = 2	

Outcome indicators

Table 12 Outcome indicators

Outcome	Indicator	Data Source	When

	[B] – Baselined [C] – Counterfactual		**Interim**	**Final**
Outcome 1: Publications/codified knowledge (including multidisciplinary research)	Number of peer reviewed papers published by participating academics projects/research in the area of immersive content or technologies.	PCF *[new academic publications]*	None indicated in PCF forms	
		Survey		23
Outcome 2: Increased understanding between industry and academia	% of organisations that have collaborated with industry/academia for the first time	Survey		56%
	% of organisations expecting to continue collaboration with the rest of participants	PCF	5/7 (71%)	
	% of organisations that indicate that they can see avenues for future collaboration with industry/academia due to the programme	Survey		100%
	Examples of improved understanding between industry and academia, and potential future collaborations	Interviews, Case studies	See Section 3.1 and case studies on ALIVE **Error! Reference source not found.**	
	[C] Academics' experience of understanding of commercial immersive sector trends increased	Survey		No change since the baseline, two said 'low' and one said 'very high' understanding
Outcome DF2: Increased adoption of design process	% of organisations indicating they have adopted design processes due to the DF2 competition	Survey	78%	90%
	% of organisations indicating the adoption of design process has improved their ability to communicate the value of projects to investors, funders or customers	DF2 Post-Project Form, Survey	93%	60% to a large extent 20% to moderate extent 15% to low extent 5% don't know

	Examples of adoption of design processes into an organisations' workflow that are attributable to the DF2 competition and its impact	Interviews, Case studies	See Section 3.2.6 and case studies 0.	
Outcome DF2: Cross-fertilisation across industries	Examples of creative immersive content/solutions developed as part of the programme applied to other industries	Interviews, Case studies	See case study on ALIVE **Error! Reference source not found.**	
	% of projects reporting the development of solutions with applications in other industries	Survey		60%
Outcome DF2: Improved design and communication for net zero	Examples of creative immersive content/solutions developed as part of the programme to address net zero	Interviews, Case studies	See case study on Filament PD ltd and Ruleo & Partners **Error! Reference source not found.**	
	% of projects reporting the development of solutions to address net zero	Survey		35% (7 out of 20)
Outcome DF2: Improved COVID-19 recovery (Build Back Better)	Examples of creative immersive content/solutions developed as part of the programme to support live venues / performances and/or distributed audiences and/or hybrid/multi-channel revenue streams	Interviews, Case studies	See case study on Crowdsurf Ltd 0 and Volume 0	
	% of projects reporting the development of solutions to support COVID-19 recovery (e.g., content/solutions developed as part of the programme to support live venues / performances and/or distributed audiences and/or hybrid/multi-channel revenue streams)	Survey		55% (11 out of 20)
Outcome 3: New immersive platforms	Number of projects'/ organisations' developing platforms	Survey		25%
	Evidence of development process	Case studies	See case studies 0	
Outcome 4: R&D roadmaps	[B] [C] – Number of organisations who have developed R&D roadmaps	Survey		60% successful vs 50%

				unsuccessful applicants
Outcome 5: Spin out companies	Number of new spin-out companies from projects from existing enterprises	Survey		1
	Number of participants who plan to exploit the project outputs by creating a spin out	PCF	11 / 30	
Outcome 6: New exploitable IP and trade secrets	% of organisations indicating they have developed new IP and/or exploitable trade secrets as a result of the programme	Survey		50%
	% of organisations that are considering / have applied for / granted IP rights of the IP used on the project	PCF	See Section 3.4.	
	Number organisations indicating they have developed new IP and/or exploitable trade secrets	Survey		10
	Examples of IP and/or exploitable trade secrets	Interviews, Case studies	See case studies 0	
Outcome 7: New revenue streams	% of organisations who report their commercial opportunities have greatly increased as a result of the project	PCF	67% greatly increased	
	[B] – % of organisations indicating they anticipate or have developed new revenue streams from new products/services or new customers.	Survey		40% developed; 55% anticipate
	[B] [C] –Value of revenue streams from immersive content	Survey		~210k in total, ~26k on average
	[B] [C]– Business and organisation turnover (median)	Survey		£102,500
	[B] [C]– Financial return on IP license agreements	Survey		£511k in total
Outcome 8: New jobs	[B] [C] – Number of full-time equivalent employees (median)	Survey		5
	Change in employment that can be attributed to the programme	Survey		
	Number of FTE jobs created during the project due to programme	PCF	Mean = 1 Median = 1	
	Number of FTE jobs expected to be retained / created in 3 years / 5 years	PCF	**3 years**	

			Created: mean = 9, median = 2 Retained: mean = 3, median = 2 **5 years** Created: mean = 24, median = 2 Retained: mean = 3, median = 2	
	[B] [C] – Number of freelancers/ contractors (FTE) (median)	Survey		2
	Change in number of freelancers/ contractors (FTE) that can be attributed to the programme	Survey		
	[B] [C] Average salary of employees	Survey		£41k
Outcome 9: New skills / talent pipeline	Number of organisations that indicate their staff have developed new skills	PCF	10 of 30, 33%	
		Survey		55% to a large extent 40% medium extent 5% limited extent
	Examples of new skills developed through project (including knowledge of design methodologies)	Interviews, Case studies, DF2 Post-Project Form	See Section 3.2.5 and case studies 0	
Outcome 10: Increased innovation/entrepreneurial attitude	Evidence of influence on attitudes and approaches of researchers to innovation and enterprise	Interviews, Case studies	See Volume case study 0	
	Evidence of change in absorptive capacity of organisations (e.g., awareness of external knowledge, ability to acquire new knowledge and apply it to organisation)	Interviews, Case studies	See case studies 0	
Outcome 11: Increased private R&D investment in	% of organisations planning on conducting further R&D to commercially exploit this project	PCF	100% (30/30)	

immersive within businesses (not connected to AotF)	Average value of additional funding expected to spend on this R&D (planned sources for financing this R&D)	PCF	Per year: Mean = £353,102 Median = £187,500 Total: Mean = £640,735 Median = £250,000	
	% of organisations that have been able to raise further funds (in addition to the match funds)	PCF	33% (10/30)	
	Value of further funds raised	PCF	Median = £100,000 Mean = £128,667	
	[B] [C] – Value of R&D investment in immersive by source (self-financed, loan, equity etc)	Survey		Self-financed:55% Loan: 0% Equity: 3% Grant: 36% Other: 6%
	[B] [C]– Value of R&D investment in immersive content	Survey		£300k

4.1.1 Impact indicators

Table 13 Impact indicators

Impact	**Indicator** [B] – Baselined [C] – Counterfactual	**Data Source**	**When**	
			Interim	**Final**
Impact 1: Increased R&D capacity and capability	[C] – Number and % of firms reporting that participating in programme has led to an increase in internal capabilities	Survey		11 (55%) said

				to a large extent 8 (40%) said to some extent
	[B] [C] – R&D intensity (Calculated as R&D investment as a proportion of turnover)	Survey		42%
	Evidence of organisational change including reduced rigidities and constraints to innovation (longer-term)	Interviews, Case studies		
Impact 2: Increased income and productivity	Value of expected future average annual financial impact on sales revenue, licensing revenue and cost reduction	PCF	X	
	[B][C] – Increase in turnover of supported businesses	Survey		£60k
	[B][C] – Increase in GVA of supported businesses (calculated) *	Survey		~£24k
	[B][C] – Change in number of FTE employees in supported businesses (median)	Survey		3 FTE
	[B] – Calculated productivity (GVA per FTE) in supported businesses*	Calculated		~8.4k
	Examples of productivity improvements	Interviews, Case studies		
Impact 3: Increased exports	% of participants reporting the project has increased the likelihood of their organisation exporting goods or services	PCF	83% (25/30)	
	[B][C] – Increase volume/value of exports	Survey		
	[B][C] – Change in turnover from exports of supported businesses	Survey		~£4k

* GVA calculated by applying a ratio of Turnover to GVA of 0.502. The ratio was calculated using the Annual Business Survey 2017 (released May 2019) and is the average ratio of Total Turnover to Approximate GVA for SIC codes aligned with the Creative Industries according to DCMS's SIC Code categorisation

Appendix C Profile of respondents

Profile of survey respondents

Table 14 Profile of survey respondents

Sector of operation	Successful applicants	Unsuccessful applicants
Software engineering	0	1
Immersive technology	7	8
Design (product, graphic & fashion)	1	2
Games	3	1
Museum, Gallery & Library	0	1
Education	0	1
Publishing	0	2
Film	1	1
Live Performance	3	2
Music	1	0
Other	4	10
Total survey responses	**20**	**29**
Response rate	**51%**	**43%**

Source: DF2 CATI survey

Table 15 Survey sample by organisation type

Sector of operation	Successful applicants		Unsuccessful applicants	
	Population	Survey sample	Population	Survey sample
Micro or small businesses	33	18	62	26
Medium businesses	4	2	2	0
Academia	2	0	4	3
Total	**39**	**20**	**68**	**29**

Source: DF2 CATI survey and application data

Profile of Interviewees

Table 16 Case study interviewees

Project	Organisation	Interviewees Phase 1
Nature Stages	Ruleo & Partners Ltd	George Simons
Feasibility study in how to put the audience at the heart of large scale live streaming events through interactive virtual crowd technology	Crowdsurf Ltd	David Agrawal
'Volume'	North Music Trust	Adam Kent
	Hammerhead interactive Ltd (Dimension Studio)	Yush Kalia
Teaching the next generation about sustainability through Mixed Reality story based play.	Filament Pd Ltd	Craig Lynn
Distributed Stitches - Design Research for Custom-fit On-Demand Clothing Microfactories	Pattern Project Ltd	Shruti Grover
ALIVE: Avatar Learning Impact assessment for Virtual Environments	Sublime Digital Ltd	Christopher Freeman
	University Of Glasgow	Sofia Apollonov

Table 17 Number of in-depth interviewees

Type of organisation	Number of interviewees
Games	1
Design	1
Live performances	2
Creative film / theatre	1
UKRI delivery team	1
Total number of interviews	**6**

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