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# Evaluation of ICURe

Annexes

Ipsos MORI



# Annex A: Econometrics Analysis

This report sets out the results from the econometric analysis of the survey results gathered from successful and unsuccessful applicants to the Innovate UK ICURe programme. The econometric analysis has been conducted with a view to estimating the causal effects of participation in the programme on a range of key outcome variables of interest, including technical readiness levels, investment in Research and Development (R&D) and whether a spin out was achieved.

The analysis presented below focuses on individual level impacts of programme participation. This allows conclusions to be formed about the impact at an individual level, but allowances are not made for displacement, multiplier or other spill over effects.

## 1.1 Summary of key findings

- **Spin-outs:** Results based on the evidence gathered through analysis of the survey findings indicate that participating in the programme increases the probability that a team establishes a spin out by 23 percentage points (from 12 percent to 36 percent). This implies that 65 percent of teams would not have established a spin-out in the absence of the programme. Checks on the robustness of these findings were made using data from administrative sources. These found similar results, and suggesting that the programme increased the likelihood that team established a by spin-out by 21 percentage points (implying that 73 percent of teams would not have established a spin-out in the absence of the programme).
- **Licensing:** There was no robust evidence, however, that the programme increased the likelihood of a licensing agreement.

## 1.2 Data

The data used for the analysis has been taken from a census survey of all team members associated with applications to ICURe. This gave a dataset of 383 individual responses covering ECRs, PIs, TTOs and business advisors associated with 188 applications. Many TTOs and business advisors were associated with multiple applications, and where this was the case, the respondent was asked to give their responses with respect to the application selected at random from their portfolio. The survey was used to collect baseline (i.e. pre-application) and follow-up measures of the outcomes of interest (April 2018) alongside a range of observable characteristics.

In terms of caveats associated with the information feeding into the analysis, the observations gathered could not be validated against independent sources and are self-reported in nature, and are therefore potentially subject to recall bias and other sources of measurement error. The assumption is also made that members of the team have accurate knowledge of the commercialisation outcomes achieved. For those awarded a place on the programme, the survey results suggested that in the large majority of cases, academic staff had a degree of involvement in the commercialisation process, and as such, there is high degree of confidence that this assumption holds. However, for those not awarded a place on the programme, it is unknown how far academic staff will be able to accurately report the commercialisation results (where respondents reported that they did not know, these observations were dropped from the analysis, though the risk arises where respondents reported inaccurate outcomes).

The primary dataset included multiple perspectives regarding the outcomes and characteristics of the same project that were not always consistent across team members (and there was variable coverage of team members across individual applications). While this would not necessarily systematically distort findings if these variations were random, if there were differential levels of response to the survey across teams that were connected with the outcomes of interest then this would have the potential to bias findings.

## 1.3 Methodology

### 1.3.1 Choice of Counterfactual and Selection Bias

A robust assessment of the causal effects resulting from participation in the ICURe programme (i.e. those effects that would not have happened in the absence of the programme) requires the selection of an appropriate group of teams or academic institutions that did not participate in the programme. Eligibility to participate in the programme was not assigned at random (either at a team or institution level), creating some complexities in selecting an appropriate counterfactual. These issues include:

- **Self-selection into treatment:** The decision to apply is a choice taken by the project team and the Technology Transfer Office and therefore there may be systematic differences between those that choose to apply and those that do not. For example, more experienced teams may not apply as they do not think they require coaching on topics covered in the boot camp. There was also evidence that at least some TTOs were filtering candidates at the application stage and only putting forwards teams they believed had the greatest probability of success. This could lead to an understatement or overstatement of the impacts of ICURe participation if basic comparisons were to be made between applicants and non-applicants.
- **Application Process:** This first problem can potentially be addressed by exploiting the competitive nature of the application process. All applicants can be assumed to share a set of common characteristics that motivated their application to the programme, and drawing a comparison sample of teams from the pool of applicants that were ultimately not awarded a place on the programme represents an improvement on a sample drawn from the general population of academic staff. However, places on the ICURe programme are awarded on the basis of a scored assessment against a number of criteria. This process introduces selectivity and provided that these judgements are made effectively, the ex-ante expectation would be that participants would outperform non-participants regardless of their participation in ICURe. For example, feedback from stakeholders suggested that many teams not awarded places on the programme were deemed at too early a stage in the development pathway to benefit from participating in the ICURe programme. As such, basic comparisons between the two groups would likely overstate the impact of the programme on the commercialisation outcomes of interest.

In light of these issues, applicants not awarded a place on ICURe are used in the analysis as the most appropriate, available counterfactual. This avoids issues associated with self-selection treatment, though any effect of selectivity introduced through the application process requires handling through the application of appropriate econometric methods.

## 1.4 Propensity Score Matching

A propensity score matching strategy enables the delivery of unbiased estimates of the treatment effects involved, provided that there are no unobserved characteristics of the applicants or their proposed project that are influential in simultaneously determining the likelihood of selection into treatment and the outcomes of interest. It is not considered that this assumption

will hold in this case, so this step of the analysis was used primarily to refine the matching of the two groups in terms of their observed characteristics, and other approaches were used to address these issues.

Different approaches to PSM were explored, including one to one nearest neighbour matching (with varying caliper values) and kernel matching. Based on an assessment of the matches (the change in the bias in the two samples and number of observations remaining in the sample), a kernel matching approach was deemed to be most appropriate for this study.

The nearest neighbour PSM approach uses the following steps:

- **Probit model:** The first step of the matching process was to implement a probit regression to predict the probability of assignment into treatment. The dependent variable in this regression was a dummy variable describing treatment status (i.e. 1 = successful, and 0 = unsuccessful), while the pre-treatment characteristics of individuals (project type, experience, TRL, R&D spend, previous involvement in spin out, salary and cohort) were used as independent variables.
- **Matching:** A kernel matching procedure was implemented, in which each successful applicant in the sample was matched to a kernel weighted average of *all* unsuccessful applicants in the sample. This has an advantage over other forms of matching (such as one-to-one matching), in that it uses more information from the comparison group. The weights employed were determined by the differences between successful and unsuccessful applicants in their estimated likelihood of assignment into treatment (as predicted by the probit models described above). An Epanechnikov kernel was used with a bandwidth of 0.06 (the default parameters in STATA). This led to the exclusion of some observations from the treatment and comparison groups where they were insufficiently similar to any members of their complementary group.

The results of the final restricted PSM model are presented below:

**Table 1.1: Results of PSM modelling**

		Treated mean	Comparator mean	% bias	Reduction in bias (%)	t-test	P > t
Project type	U	2.44	3.18	-36.8		-3.08	0.00
	M	2.44	2.49	-2.6	92.8	-0.31	0.76
Academic experience	U	11.50	10.72	8.6		0.71	0.48
	M	11.50	11.62	-1.4	83.5	-0.16	0.87
Commercial experience	U	8.64	4.73	42.5		3.28	0.00
	M	8.64	7.80	9.2	78.4	0.99	0.32
Licensing experience	U	6.67	4.36	29.3		2.36	0.02
	M	6.67	6.47	2.5	91.5	0.27	0.80
New spin out experience	U	4.67	2.43	35.4		2.72	0.00
	M	4.67	4.33	5.3	84.9	0.57	0.57
Raising equity experience	U	3.37	1.78	30.4		2.35	0.02
	M	3.37	3.12	4.7	84.4	0.50	0.62
TRL	U	3.83	3.70	7.5		0.67	0.50
	M	3.83	4.10	-14.4	-93.4	-1.55	0.12
Real R&D spend in investment	U	79709.0	1.1e+05	-7.9		-0.81	0.42
	M	79709.0	95374	-3.6	54.4	-0.48	0.63
Previous involvement in a spin out	U	0.34	0.32	3.9		0.33	0.74
	M	0.34	0.35	-2.2	44.9	-0.25	0.80
Real salary	U	7054.6	9992.8	-19.1		-1.70	0.09
	M	7054.6	7895.6	-5.5	71.4	-0.66	0.51
Cohort	U	8.32	9.66	-30.5		-2.53	0.01
	M	8.32	8.70	-8.7	71.6	-0.99	0.32

U = Unmatched Sample, and M = Matched Sample. \* if variance ratio outside [0.79; 1.27] for U and [0.79; 1.27] for M

Source: Ipsos MORI Applicant Survey (February 2019)

**Table 1.2: PSM modelling statistics**

	PS R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	% Var
Unmatched	0.064	27.36	0.004	22.9	29.3	63.1*	1.53	70
Matched	0.007	5.31	0.915	5.5	4.7	19.5	1.03	60

\* if B>25%, R outside [0.5; 2]

Source: Ipsos MORI Applicant Survey (February 2019)

## 1.4.2 Econometric Set-Up

The architecture of the ICURe programme raises the possibility of applying highly robust quasi-experimental methods to uncover the causal effects of the programme. In each round of ICURe, the scoring process creates a minimum scoring threshold above which teams are awarded places on the programme. On the assumption that idiosyncrasies in the scoring process creates random variation in scores around this threshold, those just above the threshold can be assumed to be equivalent to those just below in terms of their observable and unobservable characteristics. Comparisons between the two (an approach known as Regression Discontinuity Design) can give results equivalent in robustness to a Randomised Control Trial. However, application scores were not available for all rounds of the programme, and this approach was deemed infeasible.

In light of these constraints, a simpler difference-in-difference framework was applied in which the outcomes of interest ( $y$ ) are determined by the (1) pre-treatment characteristics of the team and the proposed project ( $X$ ) – interacted with time to preserve these controls in the estimated model, (2) participation in ICURe ( $P$ , a dummy variable taking the value of 1 if the team was awarded a place on the programme and 0 otherwise), (3) a set of unobserved team and project characteristics that do not vary over time ( $\lambda$ ) and time ( $t$ , which allows for all teams making some degree of progress over time):

$$y_{it} = \phi + \alpha t + X_{i0}\beta t + \partial P_{it} + \lambda_i + \varepsilon_{it}$$

The first difference of this equation can be estimated using econometric methods, and as unobserved characteristics are assumed to be constant over time, the first difference estimator controls for both observed and unobserved differences between team members and their associated projects:

$$y_{it} - y_{it-1} = \Delta y_{it} = \alpha + X_{i0}\beta + \partial \Delta P_{it} + \varepsilon_{it}$$

The matched sample described in section 1.4 was used to implement a set of regression analyses aimed at isolating the causal effect of the Innovate UK ICURe programme on the outcomes of interest.

The specification of the models used for the Difference in Difference (DiD) analysis was informed by the distribution of outcomes variables to be modelled (as outlined in section 1.4.4). One outcome of interest was bounded at zero (change in TRL), implying that Ordinary Least Squares (OLS) regression analyses would be inappropriate. A decision was made to model these outcomes on the basis of a Negative Binomial distribution.<sup>1</sup>

## 1.4.3 Issues with the Interpretation of Results

The following issues should be borne in mind when interpreting the results:

- **Time varying unobservables:** Clearly the model does not allow for time varying unobserved differences between teams. The case study evidence suggests that some key unobservables – such as motivation or commitment to the commercialisation of academic research can change rapidly over time, with the potential to bias the findings. The presence of these types of issues cannot be formally tested and the results cannot be considered more robust than Level III on the Maryland Scale.
- **Validity of the counterfactual scenario:** The analysis compares teams that were awarded and not awarded places on the ICURe programme. This makes the assumption that the teams not awarded a place on the programme either would

<sup>1</sup> See for Quasi-Poisson versus Negative Binomial Regression: How should we model over-dispersed count data? Hoef and Boveng, 2007

have had some involvement in the commercialisation of the research or had knowledge of the commercialisation outcomes of interest. This assumption is partially weakened by evidence uncovered in the research that TTOs may choose to undertake the market validation process internally or engage an external party, and estimates of the effects of the programme on network development need to be interpreted in this context (i.e. the results are valid in the sense that they estimate the additional relationships formed by participating teams, though some of those links may have otherwise been made by the TTO and this is not reflected in the results).

- **Crowding out:** It is possible that ICURe increases the commitment of TTOs to supporting teams awarded places on the programme (or receive a positive signal from the Options Roundabout that commercialisation is a viable option). If such an increase is accompanied by reduced commitment to parallel or future commercialisation projects, there may be offsetting effects that are not captured in this analysis. No evidence of this nature was uncovered during the evaluation, though institutional level analysis will help validate the extent of any crowding out

#### 1.4.4 Key Outcomes

188 teams participated in ICURe from 2014 to 2018. The aim of these grants was to increase the success of academic research commercialisation through the spin out of new companies, upskill Early Career Researchers (ECRs) in entrepreneurship and market knowledge, and to provide evidence to support a national rollout of the programme.<sup>2</sup>

The headline outcomes that have been explored within this paper are:

1. **Progress Index in resolving business model issues** – The survey collected observations across a range of common business model issues to reflect the challenges faced by participants using a scale of 1-10. The responses were then aggregated to reflect the progress made on overall business model issues from a scale of 10 – 90.
2. **Additional contacts Index** – The survey collected data on the number of additional stakeholders made by applicants which included, customers, suppliers, investors and competitors. The results were aggregated to reflect engagement across all stakeholder groups.
3. **Skill capability Index** – The survey captured respondent's self-perception of skill capability across a range of skills using a 7-point scale. This was then aggregated to create an index to reflect the overall skill capability of the respondent.
4. **Total grant value** – This represents the total amount secured through public or charitable grants for additional research and development.
5. **R&D investment** – This encompasses any additional investment that has been made in research and development into the technology at the heart of the project since previous survey participation or application submission.
6. **Total equity since spinout** – This includes the total equity investment that has been raised since the spin out was established.

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<sup>2</sup> Additional contact index, total equity since spinout, change in ECR salary, probability of licensing, and probability of sales arising from spinning out were analysed but the model did not find any significant difference and therefore, these variables have not been reported



7. **Change in ECR salary** – This variable is used to analyse whether there has been any change in Early Career Researcher salaries. It has been calculated as the difference between the estimated salary reported before the application and the level at the time of the survey.
8. **Change in Technical Readiness Levels (TRLs)** - This is used to analyse the progress of the technology at the heart of the application which, though not explicitly a focus of ICURe, could be affected either positively or negatively by the programme. It has been calculated as the difference between the reported level before application and the stated level at the time of the survey, using the 9-point Technology Readiness Level scale
9. **Outcomes to take the project forward** – This incorporates a range of outcomes taken by participants to take the project forward and includes but is not limited to: engaging with stakeholders, establishing a spin out, or applying for Aid for Start Ups.
10. **Licensing** – This measures whether the participant has been successful in licensing the IP underlying the project.
11. **Public/charity grants for additional research** – This demonstrates whether the participant has been successful in securing public or charitable grants for additional research and development.
12. **Private contracts from IP** – This variable stipulates whether participants have been successful in securing private research contracts in connection with the IP at the heart of the project.
13. **Spin out revenue** – This variable indicates whether any revenue has been raised through sales or licensing of the spin out.

#### 1.4.5 Controls

A number of control variables were included in the model as outlined in the list below:

1. **Treatment effect** – This variable distinguishes between those teams that participated in the programme and those that did not.
2. **Expected outcome** – This accounts for the expected outcome of the project forming the focus of the application. This was included as those who expected or planned for certain outcomes may be closer to reaching it than those who did not.
3. **Gender** – This variable was included to decipher the impact of gender on the outcomes in question.
4. **Country of birth** – This variable was incorporated to analyse the impact of birth place on the outcomes of interest.
5. **Application score** – This is the score that is given to the initial ICURe application and is used as the only way to control for the quality of the project that forms the focus of the application. This is therefore the only way the models presented can control for selection bias.

## 1.5 Results: Individual Level

This section sets out the results from the analysis of individual responses. Standard errors used in the individual level analysis have been clustered at the project team level and therefore take into account a degree of variation in the responses provided across team members.

### 1.5.1 Key Findings

The key findings from the first stage of econometric analysis suggest that participation in the ICURe programme:

- **Increased the progress made against business modelling issues.** The model used suggests that those who rated their progress against a range of common business model issues presented in the survey increased progress by 17 points.
- **Increased stakeholder contacts.** The model implies that as a result of successfully participating in the programme, projects engaged with an additional 28 stakeholders.
- **Increase skill capability.** The model estimates that the skill capability of ECRs across a range of variables has increased by 11 points.
- **Increased total grant value.** The model presented finds that of those who had been successful in securing public or charitable grants for additional R&D since they were last contacted experienced a 110 percent increase in funding.
- **Increased investment in R&D.** Since submitting the application or when respondents were previously contacted, the model implies that investment in R&D increased by 226 percent.
- **Increased equity since spinout.** As a result of participation, the model predicts a 596 percent increase in equity raised since the spin out.
- **Increased ECR salary.** The model suggests that as a result of the programme, ECR salary's increase by 60 percent.<sup>3</sup>
- **Improved TRLs.** The model predicts that over the period from application to the time of the current survey, technical readiness levels have increased by 0.4.
- **Increased probability of engaging with stakeholders to take the project forward.** The model predicts that engagements with stakeholders increased by 25 percentage points.
- **Increased probability of establishing a spin out to take the project forward:** The model insinuates that as a result of participating in the programme, successful candidates increased the probability of establishing a spin out by 17 percentage points.
- **Increased probability of registering or applying for property rights to take the project forward.** It is estimated that participation causes the probability of registering IP connected to the technology to increase by 20 percentage points.

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<sup>3</sup> This variable was self-reported and the banded nature of the question may mean that this outcome is less precisely defined and therefore may be over or under estimated.

- **Increased probability of engagement with licensees to take the project forward.** The model implies that the probability of engagement with licensees increases by 11 percentage points.
- **Increased probability of public funding for further research to take the project forward:** Participation in the programme led to the probability of securing public funding to take the project forward to increase by 17 percentage points.
- **Increased probability of private funding for further research to take the project forward:** Participation in the programme led to the probability of securing public funding to take the project forward to increase by 13 percentage points.
- **Increased probability of public/charity grants for additional research:** As a result of the programme, those who were successful increased their probability of securing public funding for further research by 23 percentage points.
- **Increased probability of the spin out generating sales or licensing.** The model assumes that as a result of a successful application, the probability of the spin out created generating revenue increases by 30 percentage points.

The results of the regressions are presented in more detail below in tables 6.3 – 6.6.

### 1.5.2 Estimated outcome probabilities as a result of participation in the programme

**Table 1.3: Likelihood of outcomes as a result of participation in the programme compared to the likelihood without participation**

Outcomes	Without ICURe probability (%)	With ICURe probability (%)
TRL	53.01	85.84
Engaging with stakeholders to take the project forward	46.63	72.84
Establishing a spin out to take the project forward	10	26.62
Registered new IP to take the project forward	11.05	31.55
Engaged with licensees to take the project forward	25.56	37.15
Securing public funding to take the project forward	43.18	61.71
Securing private funding to take the project forward	16.14	30.11
Public/charity grants for further research	40.64	66.03
Spin out generating revenue from sales or licensing	13.5	47.74

Table 1.4: OLS and Negative Binomial regression

VARIABLES	OLS						Negative Binomial	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Progress Index	Additional contacts Index	Skill capability Index	Ln total grant value	Ln R&D investment	Ln total equity since spinout	Ln change in salary	Change in TRL
1.Treatment	17.13***	27.96***	10.94***	1.095**	2.255***	5.956***	0.602*	0.442**
	(7.36e-05)	(0.00885)	(2.37e-05)	(0.0317)	(0.00266)	(0.00676)	(0.0575)	-0.0387
2. New or improved product	7.750	2.726	2.085	-0.0456	2.437**	1.803	0.138	0.274
	(0.120)	(0.797)	(0.444)	(0.919)	(0.0110)	(0.300)	(0.740)	-0.15
2. New or improved service	-3.201	-0.732	1.023	1.199***	1.037	0.509	0.427	-0.0825
	(0.491)	(0.942)	(0.772)	(0.000827)	(0.141)	(0.761)	(0.245)	-0.663
2. New or improved process	10.82**	27.67**	0.700	0.115	0.849	1.964	-0.132	0.247
	(0.0412)	(0.0272)	(0.780)	(0.807)	(0.307)	(0.454)	(0.740)	-0.268
2. New or enhanced business model	13.50**	-1.335	0.958	1.269**	2.337***	1.471	-0.254	0.109
	(0.0201)	(0.908)	(0.623)	(0.0184)	(0.00323)	(0.459)	(0.505)	-0.573
3. Gender - Female	-1.742	9.202	-0.702	0.253	-0.226	-0.249	0.445	-0.549*
	(0.723)	(0.525)	(0.848)	(0.610)	(0.817)	(0.882)	(0.336)	-0.0625
4. Continent of birth - Asia	28.01**	29.53**	-4.528	-1.385**	-1.832	-7.816***	0.688	-0.278
	(0.0309)	(0.0124)	(0.353)	(0.0479)	(0.364)	(0.000507)	(0.267)	-0.69
4. . Continent of birth - Australasia	34.11***	31.88*	-8.474		1.488		5.812	-0.478
	(0.00445)	(0.0759)	(0.301)		(0.476)		(0.103)	-0.485
4. Continent of birth – North America	23.85	81.05*	-14.14**	-2.523***	-2.843	-7.068	3.077	0.46
	(0.114)	(0.0910)	(0.0482)	(0.00566)	(0.361)	(0.176)	(0.203)	-0.516
4. Continent of birth – Other European	20.38*	45.67***	-7.919*	-1.732**	0.204	-6.326***	0.294	-0.0731
	(0.0886)	(0.00103)	(0.0963)	(0.0244)	(0.920)	(0.00111)	(0.542)	-0.915
4. Continent of birth – South American	40.36***	49.13**	-0.846	-3.144***	-2.024	-10.52***	1.599	0.753
	(0.00307)	(0.0169)	(0.856)	(4.37e-07)	(0.532)	(3.84e-05)	(0.429)	-0.287
4. Continent of birth - UK	23.23**	44.68***	-7.558**	-2.418***	-0.373	-6.892***	0.0961	-0.0442
	(0.0471)	(0.000155)	(0.0331)	(0.000313)	(0.845)	(2.88e-07)	(0.784)	-0.948
5. Application score	0.108	-2.458	-0.00641	-0.0872*	-0.247*	-0.402*	-0.0949*	-0.111***
	(0.894)	(0.207)	(0.982)	(0.0981)	(0.0504)	(0.0815)	(0.0977)	-4.27E-05

	0.677	-5.941	54.43***	13.56***	7.956***	9.589***	0.914	1.293*
Constant	(0.962)	(0.769)	(0)	(0)	(0.00117)	(0.00101)	(0.209)	-0.0872
Observations	365	208	136	95	229	86	365	215
R-squared	0.152	0.051	0.279	0.366	0.173	0.182	0.072	

Table 1.5: Transformed Logistic regression

VARIABLES	Logistic – Transformed							
	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Engaged with potential stakeholders	Business plan for spin out	Established a spin out	Registered new IP	Engaged with licensees	Public funding for further research	Private funding for further research	Applied for AFSU
1. Treatment	0.2469553*	0.0711068	0.166485*	0.2045959*	0.106567*	0.1732867*	0.1320951*	0.0012313
2. New or improved product	0.1103097	0.0109131	-0.0286137	0.1589277*	0.2787595*	0.2041234*	0.1438968*	0.0616099
2. New or improved service	0.0045442	-0.0125804	0.0755361	0.0543373	0.0190804	0.0556648	0.1781618*	-0.0075416
2. New or improved process	0.1600719*	0.0852738	0.0054369	0.0684122	0.1554033*	0.1364592	0.0490098	0.0182553
2. New or enhanced business model	0.2113498*	0.0643919	0.038827	0.0395264	0.2604645*	0.2016309	0.1762076*	0.0769782
3. Gender - Female	0.0770741	-0.0293825	0.010574	-0.0555898	0.036054	-0.1024705	-0.0183893	-0.0474264
4. Continent of birth - Asia	0.2598497	0.2422463*	-0.06938	0.2338922*	0.1055093	0.4960553*	0.0275796	-
4. Continent of birth – Australasia	-	0.4530557	0.428271	-	0.4205416	-	-	-
4. Continent of birth – North America	0.2953019	0.2288813	-0.0717622	0.0625301	0.4205416	0.5880118*	0.3759176	-
4. Continent of birth – Other European	0.3678723*	0.1006864	-0.0414242	0.1494496	0.1745554	0.4592601*	0.0484874	-
4. Continent of birth – South America	0.3733046	0.4969582*	-0.0354185	0.0304415	0.2368873	0.5533861*	-0.044322	-
4. Continent of birth - UK	0.3549795*	0.1902947	-0.0152665	0.0892587	0.1564729	0.4353533*	0.0020346	-
5. Application score	-0.0028025	0.028278*	-0.0069022	-0.0053851	0.0011652	-0.0017351	-0.0032485	0.0087427
Observations	365	365	365	363	365	363	363	357

Robust pval in parentheses. \*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 1.6: Transformed Logistic regression

VARIABLES	Logistic - Transformed			
	(10)	(11)	(12)	(13)
	Licensing	Public/charity grants for additional research	Private contracts from IP of the project	Spin out generating sales or licensing
1. Treatment	0.0113405	0.2321747*	-0.0630893	0.3002967*
2. New or improved product	0.0889525*	-0.001514	0.107833	-0.2295151*
2. New or improved service	0.0839987*	-0.001514	-0.0148721	0.0969497
2. New or improved process	-0.1221442*	0.1623541	0.0571104	-0.0184698
2. New or enhanced business model	0.0639727*	-0.1581492*	-0.2381329	-0.2679095*
3. Gender - Female	0.1021859*	-0.0553387	-0.0670628	-0.3090313*
4. Continent of birth - Asia	-0.1416078	-0.0221324	-	0.1367517
4. Continent of birth – Australasia	-	-	-	-
4. Continent of birth – North America	-	-	-	0.1457341
4. Continent of birth – Other European	-0.1681635	-	-	0.1023448
4. Continent of birth – South America	-	-	-	-0.0252747
4. Continent of birth - UK	-0.1760454	-	-	0.0687009
5. Application score	0.0023526	-	0.0139208	-0.024777*
Observations	351	191	98	107

▪ Robust pval in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

▪

## 1.6 Comparison of findings

This section draws a comparison between the survey analysis outlined above and the secondary data source (Companies House and Pitchbook) analysis outlined in Annex B.

- **Impact on spin-outs:** Both sources of evidence indicated that as a result of the programme, the probability of establishing a spin out increased. Survey analysis estimated this probability to be 27 percent compared to the secondary data analysis which estimated this to be 29 percent.
- **Estimated additionality of spinouts:** Survey analysis implies that 62 percent of spinouts created by ICURe teams would not have been established in the absence of the programme compared to 73 percent estimated by secondary data analysis.<sup>4</sup> This results in an estimated additional total number of spinouts of 30 and 48 respectively.<sup>5</sup>

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<sup>4</sup> Equal to  $(26.62-10)/26.62$

<sup>5</sup> Equal to  $0.62*66$  and  $0.73*66$

# Sub-annex A

**Table 1.7: Untransformed logistic regression**

VARIABLES	Logistic - Untransformed							
	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Engaged with potential stakeholders	Business plan for spin out	Established a spin out	Registered new IP	Engaged with licensees	Public funding for further research	Private funding for further research	Applied for AFSU
1. Treatment	1.122***	0.346	1.181***	1.311***	0.544*	0.752**	0.806**	0.0149
	(0.000113)	(0.318)	(0.00269)	(0.000349)	(0.0973)	(0.0132)	(0.0307)	(0.978)
2. New or improved product	0.526	0.0538	-0.201	1.023**	1.425***	0.902**	0.873**	0.747
	(0.143)	(0.885)	(0.633)	(0.0103)	(0.000138)	(0.0180)	(0.0367)	(0.192)
2. New or improved service	0.0217	-0.0620	0.531	0.350	0.0975	0.246	1.081***	-0.0914
	(0.949)	(0.861)	(0.164)	(0.343)	(0.772)	(0.472)	(0.00222)	(0.875)
2. New or improved process	0.763*	0.420	0.0382	0.440	0.794*	0.603	0.297	0.221
	(0.0740)	(0.257)	(0.938)	(0.333)	(0.0692)	(0.153)	(0.504)	(0.702)
2. New or enhanced business model	1.007**	0.317	0.273	0.254	1.331***	0.891*	1.069**	0.933
	(0.0284)	(0.474)	(0.607)	(0.530)	(0.00389)	(0.0534)	(0.0319)	(0.150)
3. Gender - Female	0.372	-0.147	0.0735	-0.376	0.181	-0.452	-0.113	-0.656
	(0.336)	(0.717)	(0.871)	(0.395)	(0.607)	(0.174)	(0.777)	(0.372)
4. Continent of birth - Asia	1.264	1.405	-0.503	1.610	0.665	2.917**	0.169	0.0794
	(0.155)	(0.184)	(0.612)	(0.174)	(0.572)	(0.0272)	(0.874)	(0.901)
4. Continent of birth – North America	1.425	1.344	-0.524	0.578	1.302	3.342**	1.830	-0.0180
	(0.165)	(0.268)	(0.677)	(0.677)	(0.338)	(0.0400)	(0.189)	(0.988)
4. Continent of birth – Other European	1.764**	0.697	-0.282	1.156	1.023	2.755**	0.289	-0.885
	(0.0444)	(0.510)	(0.773)	(0.329)	(0.380)	(0.0333)	(0.785)	(0.134)
4. Continent of birth – South America	1.790	2.519*	-0.239	0.308	1.321	3.177*	-0.305	3.170**
	(0.274)	(0.0889)	(0.870)	(0.841)	(0.412)	(0.0962)	(0.864)	(0.0196)
4. Continent of birth - UK	1.702**	1.164	-0.0991	0.774	0.933	2.651**	0.0129	
	(0.0423)	(0.250)	(0.917)	(0.500)	(0.417)	(0.0373)	(0.990)	
5. Application score	-0.0134	0.139*	-0.0485	-0.0347	0.00596	-0.00767	-0.0197	0.106
	(0.821)	(0.0558)	(0.383)	(0.431)	(0.902)	(0.893)	(0.738)	(0.243)
Constant	-2.374**	-3.532***	-1.651	-3.577***	-3.482***	-3.761**	-2.791**	-3.877***
	(0.0241)	(0.00655)	(0.144)	(0.00432)	(0.00602)	(0.0111)	(0.0268)	(1.09e-05)
Observations	363	365	365	363	365	363	363	357

• Robust pval in parentheses. \*\*\* p<0.05, \*p<0.1



Table 1.8: Untransformed Logistic regression

VARIABLES	Logistic - Untransformed			
	(10)	(11)	(12)	(13)
	Licensing	Public/charity grants for additional research	Private contracts from IP of the project	Spin out generating sales or licensing
1.Treatment	0.230 (0.687)	1.043** (0.0252)	-0.351 (0.612)	1.767** (0.0228)
2. New or improved product	1.784** (0.0266)	-0.00696 (0.987)	0.605 (0.412)	-1.226* (0.0512)
2. New or improved service	1.685*** (0.00198)	-0.260 (0.508)	-0.0834 (0.894)	0.518 (0.356)
2. New or improved process	-2.450 (0.101)	0.746 (0.157)	0.320 (0.666)	-0.0987 (0.901)
2. New or enhanced business model	1.283* (0.0726)	-0.727* (0.0967)	-1.336* (0.0678)	-1.431* (0.0532)
3. Gender - Female	1.624*** (0.00181)	-0.251 (0.557)	-0.383 (0.543)	-1.837*** (0.00962)
4. Continent of birth - Asia	-1.528 (0.306)	0.176 (0.732)	0.681 (0.327)	0.743 (0.722)
4. Continent of birth – North America		-1.253 (0.216)		0.790 (0.733)
4. Continent of birth – Other European	-2.008 (0.164)	-0.125 (0.795)	1.342** (0.0375)	0.561 (0.787)
Continent of birth – South America				-0.148 (0.949)
4. Continent of birth - UK	-2.178 (0.108)			0.382 (0.852)
5. Application score	0.0472 (0.768)	-0.102 (0.202)	0.0781 (0.376)	-0.132* (0.0749)
Constant	-4.246** (0.0347)	0.835 (0.337)	-1.815 (0.111)	0.274 (0.904)
Observations	351	191	98	107

• Robust pval in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0

# Annex B: Case study reports

## Case study 1: Bioprocessing methods to maintain the viability of osteochondral allograft tissue

### Summary

This Cohort 8 project team, based outside the SETSquared group of HEIs, sought to validate the commercial properties of a surgery designed to alleviate joint issues and disease in humans. This applied research project, which started before participation in ICURe involved an NHS subsidiary as a research partner, and was already focused on understanding potential commercialisation options.

The ECR and PI showed an interest in developing commercialisation skills and the PI held some previous experience supporting ICURe alumni projects. The programme was shown to support the ECR to plan and deliver a market validation exercise more rapidly and efficiently than would have been achieved otherwise. In particular, the exercise provided strong validation for the commercialisation strategy developed prior to the programme and provided the team with a more nuanced understanding of the market.

At the time of interview, a licencing deal was being pursued by the project team, but no deal was in place. Challenges in maintaining relationships with contacts made during the exercise and limited resources to support the validation work required to secure a deal were cited as key barriers.

The ECR did not lead additional commercialisation efforts after the completion of the ICURe project as they focused on finalising their PhD – afterwards, the ECR indicated a career in business (rather than academia) was attractive because of the experiences gained on ICURe. Residual challenges in changing the culture of commercialisation at the HEI remain, the most acute being the perception among senior academics that publication activity is more important for acquiring REF funding than pursuing commercialisation opportunities.

### Background

The research forming the focus of the ICURe application sought to improve the use of tissue transplants in human cartilage regeneration surgeries (osteochondral allografts). The technique was already available as a surgery at the inception of the research project, but two challenges were thought to be associated with the use of the procedure. First, the reliance on donated tissue, which could only remain outside of human body for up to two weeks, made it difficult to predict when and if surgeries could take place. Second, if successful, the procedure had a limited lifespan, with interviewees reporting it would not typically be effective after 10 years. In response to these challenges, the research projects aimed to:

- increase the amount of time tissue used for the procedure could remain outside of a human body; and,
- increase the lifespan of the procedure such that it would not need to be repeated throughout a patient's life.

### Initial R&D Activity

The initial research, a £30,000 university studentship awarded in 2016, began in response to discussions with clinicians about the challenges associated with the surgery described above. This project was also part funded an NHS subsidiary, which was considering making the surgery available in the UK.

The project was led by a PI (who was the ECR's PhD supervisor at the time) and supported by the ECR with eight years' academic experience. Although the research did not form the focus of the ECR's PhD project, it was in a complementary

field of study. Finally, two advisers from the partnered NHS subsidiary were included in the team – one of which held over 20 years in academia and forming university spinouts respectively.

Initially, the team expected to commercialise the technology by providing a higher quality product at a lower price than products currently on the market used by surgeons. The team mainly thought commercial success would be achieved by first targeting the US healthcare market, due to the more established private healthcare insurance markets present.

This view was also informed by the interest in expanding the project's network to go beyond their existing NHS partnership. However, at the point just prior to applying to ICURe, the team had not made any attempt to commercialise any outputs of the project, although the ECR did hold some prior experience in technology licencing in relation to another project. In addition, the NHS had previously tried to launch a similar product to market but failed to overcome the technical challenges associated with the longevity of the surgery, as described above.

At the time of application, the project had planned a programme of testing activity to check the procedure was safe for human use. Although clinical trials were not a prerequisite to commercialisation (because the surgery made use of human tissue for use in humans) the technique would eventually need to be approved by a recognised regulator, which was estimated to take 2-3 years in the UK market by the NHS subsidiary.

Prior to making an ICURe application, the team had made the TTO aware of the research project and the proposed commercialisation strategy. However, the team faced difficulties in securing support from the TTO to exploit this technology because the office held limited expertise in surgeries using human tissue transplants – this required additional resources from the project team to build the technical understanding.

## Application to ICURe

The university has a central commercialisation team that supports all research departments to commercialise research outputs. The team's operation is managed by less than 10 FTE staff and was suggested to suffer from resource constraints and limited technical knowledge in some research areas.

No pre-selection process for ICURe was administered by the university, and the TTO did not enforce any team to raise the interest in applying to the programme beforehand.

The project PI had been a participant in two historic ICURe projects and raised the opportunity to the ECR directly. The team submitted an ICURe application for three reasons:

- **Interest in commercialisation:** Both the PI and the ECR had an interest in commercialising research outputs (and the PI held previous experience in doing so).
- **Limited TTO experienced in biosciences:** The team were keen to incentivise the HEI TTO to become more involved in the project than they had been to date; the ECR and PI reported that, at the time, additional validation of the commercial traits of the technology may have encouraged the TTO to consider the proposition more seriously.
- **Challenges in working with the NHS subsidiary:** The project team faced challenges in working with the NHS subsidiary from a bureaucratic and resourcing standpoint. This made the opportunity to identify alternative exploitation routes, operating privately outside of the UK, more appealing.

The ECR led on the development of the application, and the PI provided guidance to make the application more focused on the commercial traits of the technology. In total, the application was completed in around two days, which was thought to be proportionate in terms of the funding and support received. However, much of the content used in the application had already been developed as part of the research project activities. In addition, the PI's previous experience in developing ICURe applications made the process more efficient in terms of identifying relevant content.

While the two additional advisers were made aware of the application, the TTO was only informed after the application had been submitted, meaning it did not provide any input into its development. However, highlighting the application had been made after its submission did not cause any frictions between the research team and the TTO, which was supportive of the effort.

The development of the application was beneficial because it encouraged the project team to focus on commercial traits thought to be of most value – for example, several other product characteristics that could have been tested during the market validation exercise were ruled out at the application stage because the project team decided to focus on addressing the two challenges highlighted above.

## Experiences during ICURe

This subsection provides an overview of the Bootcamp, market validation and options roundabout activities completed as part of the programme.

### Four-day residential Bootcamp

The Bootcamp was reported to have been effective in preparing the team for the market validation exercise, mainly because the engaging delivery team provided team members opportunities to network with peers from different HEIs and improved their interpersonal and entrepreneurial skills of the ECR:

- **Peer-support and learning:** The ECR indicated it was beneficial to share experiences and learn from other ECRs on the programme because it solidified the need to focus on the commercial traits of the technology rather than technical work they had been working on previously.
- **Interpersonal skills:** The ECR reported the Bootcamp supported an understanding of how the programme would be administered. However, the interview suggests they may have actually been referring to building business development and interpersonal skills, as the examples provided by the ECR at interview referenced useful training on setting up meetings, developing professional networks and writing emails to send to prospective customers and suppliers.
- **Role-playing activities:** A series of 'mock' interviews were conducted with the Bootcamp team to provide the team with an opportunity to practice explaining their technology to a non-technical audience. These sessions were said to be effective in teaching the ECR how to build a rapport with new contacts.

The team also jointly developed a business model canvas which was said to be a helpful way to frame the technology in a commercial setting. While two templates of the canvas were provided (one detailed and one condensed) the ECR preferred to use the more detailed canvas to support decision making because they personally preferred to have access to more detail about the technology.

The action planning session was said to be a useful mechanism for thinking about the practical aspects of the exercise, particularly in identifying which individuals and organisations across multiple geographies could be feasibly targeted as part of the exercise. The PI's previous experience on ICURe was used at this stage to focus the project on a set number of geographical areas, as it was suggested that the ICURe delivery team were conscious about approving visits to multiple locations requiring long-distance travel – this experience was reported to have made the action planning process more efficient.

Without the Bootcamp, the ECR reported they would not have developed such a clear and detailed plan to undertake a market validation exercise and may have lacked the confidence needed to approach new contacts to discuss the technology which was suggested to have accelerate the process.

## Market Validation Exercise

At the outset, the ECR intended to interact with potential customers, suppliers and competitors as part of the exercise:

- **Customers:** Orthopaedic surgeons and veterinary professionals, with the latter engaged with to consider the possibility of applications in animals. Key end beneficiaries of the surgery were also consulted to collect patient views, particularly from contacts in the armed forces (given the prevalence of related joint conditions).
- **Suppliers:** Tissue banks that would provide human samples to support surgeries.
- **Competitors:** Physiotherapists offering competing therapies to the proposed surgery were also engaged with to understand their views on the efficacy and competitiveness of the proposed technology enhancements.

The team sent out a large volume of email communications to prospective contacts across all of these groups. While the ECR initially targeted contacts at the middle-management level, over the course of the programme, they were more successful in getting responses from more senior contacts.

Overall, the team reported 200 new contracts were made as a result of the project – prior to the programme the team reported less than 10 contacts had been made regarding the commercial potential of the project.

The market validation exercise did not result in any fundamental changes to the technical traits of the surgery or the original commercialisation strategy developed by the team. However, the data collected through the exercise provided validation that the approach was commercially viable and provided the team with a more nuanced understanding of how to exploit the technology:

- **Validation:** The ability to collect independent views on the technology from a range of individuals was useful in validating the proposed exploitation strategy. A key result was the collection of evidence that a surgery with enhanced shelf-life tissue samples and longevity was of value to potential customers – for example, surgeons reported they were keen to make use of the surgery, but they often did not have the human tissue available to use because of the issues with storage.
- **Insights on challenges with existing surgery:** The ECR completed a meeting with the senior surgeon who pioneered the surgery to begin with. They were supportive of the market validation exercise and the technology under development. The discussion identified and described the issues with the current product and provided a set of recommended refinements to develop the project technology further. The case suggests that because the surgeon did not have an academic research background, they were very supportive of academics developing their ideas further.
- **Price setting:** The exercise provided an understanding of the expected level of market demand for the product. It also identified that a higher price could be secured as a result of differentiating the product from the existing competition option and the need for additional processing in a tissue bank.
- **Identification of optimal tissue bank partner:** Securing a suitable tissue bank partner for the project was reported to be key in commercialising the technology. The exercise supported the identification of a suitable US bank which was sufficiently large and was found to be used by the majority of surgeons in the field.

The Business Model Canvas was maintained and reviewed regularly throughout the exercise by the ECR, who reported it as a useful tool to review in preparation for meetings - although it was never directly used to frame discussions with contacts.

In practice, the action plan developed as part of the Bootcamp could not be implemented as initially planned, because it did not fully consider the time taken to travel between locations or accommodate flexibility with respect to meeting times and locations.

## Team support

Team members provided a range of varying and complementary support to the ECR throughout the exercise but they did not influence the approach taken or expected commercialisation strategy developed:

- **TTO:** After the team submitted an ICURe application, the TTO completed its own desk research into the technical traits of the technology in order to support the team to make more informed decisions as part of the programme. However, the TTO provided limited support during the exercise due to several personnel changes for personal and professional reasons. To address these short term TTO resourcing issues, the final TTO team member ended up being a temporary freelancer who did not maintain their post after the programme completed.
- **PI:** The PI was reported to be very helpful and constructive by the ECR during the course of the exercise – for example, the ECR consulted with the PI after meetings to discuss the implications of new evidence and provided a ‘voice of reason’ to the ECR to support them in seeing the results in a wider context.
- **Additional advisers:** Two additional team members that work for the NHS were included on the project, both with practitioner experience. These team members’ main contribution was to provide a contact lists to support the validation exercise. These lists were reported to be especially useful for getting in touch with surgeons in the early stages of the programme. In addition, one adviser also provided guidance and lessons learnt on why the NHS’ attempts to previously commercialise a related technology was not successful. However, while the ECR reported during the survey that these advisers had relevant industrial experience, they were less convinced their skills were aligned to the needs of the project, and their roles on the project were not always clear.

## Options Roundabout

The Options Roundabout provided a useful opportunity to synthesise the results of the exercise and collect independent views on the proposed commercialisation strategy.

### Preparation

The ECR developed the Options Roundabout presentation in the first case, with guidance from the PI to finalise the technical content of the slides. The presentation was then reviewed by the TTO and additional advisers, whose comments focused on the design and delivery of the content rather than the content itself. Finally, the ECR delivered the presentation to the team to practice how it would be delivered.

The ECR highlighted that the process of developing the presentation was beneficial because it forced the team to triangulate the results of the market validation exercise. It also provided the ECR with new opportunities to present to a range of independent experts – an opportunity that was suggested to not have been immediately available to the ECR in the absence of the programme, given their focus on delivering lab-based R&D activities.

The team indicated that a sufficient level of support was provided by the ICURe team when developing the presentation. Where additional support was required, the ICURe delivery team were reported to have provided useful guidance, especially in relation to formatting and content, and responded to requests in a timely fashion.

## Result

The delivery of the presentation went ahead without any issues, and the panel supported the team's proposition to pursue a licence with a large US tissue bank. Receiving validation that their approach was thought to be correct at the time was a key benefit of these process. Finally, none of the panellists agreed to provide long term support to the project.

## Suggested Improvements

Overall, the project team were satisfied with the way the programme was delivered and highlighted that no major changes to the programme were needed.

However, it was highlighted that opportunities for further funding to support a licencing deal may have been beneficial. Typically, securing a licence requires a programme of focused validation and testing activity, in addition to the administration required by the HEI.

## ICURe Commercialisation Impact

The team decided to attempt to secure a licencing deal with a large US tissue bank; a decision which was supported by the Options Roundabout.

An additional member of the project team continued talks with the selected tissue bank about licencing the technology and made several visits to the bank to develop the opportunity. However, these efforts were halted due to illness and were only just about to re-commence at the time of interview.

The ECR was only involved to a limited extent, beyond taking part in several handover meetings with the TTO, due to the need to focus on finalising their PhD (which was due for submission within four months of completing ICURe). The ECR had been offered a contract extension to continue working on the research project associated with the technology. Although, despite having a position made available for them, jointly funded by the university and the NHS, the ECR also highlighted an interest in taking on a different role outside of academia.

In summary, some progress had been made since the programme finished, but at the time of interview a licencing deal had not been secured by the university, indicating any commercialisation attempts were at an early stage.

## Non-commercial outcomes

The following non-commercial outcomes have been achieved since the programme finished, although the case suggests that they may have been achieved in the absence of the programme:

- **Technical progress:** The technical readiness was reported to have increased from 4.5 to 6 on average as a result of background R&D activity completed during the programme.
- **R&D activity:** This additional R&D activity supported an understanding of the efficacy of the treatment in the long term in comparison to other treatments. It was funded by the university and the NHS prior to the start of the programme and no new funding was secured since the project completed ICURe and is due to terminate in 2023.
- **Intellectual property rights:** At the time of interview, a patent was being registered for the technology under development. This registration process was being led by the TTO. However, it was expected that a patent would be filed for the technology, even in the absence of the programme because of standard HEI procedures relating to commercialisation.
- **NHS surgery launch:** As a result of the validation exercise, the NHS have made the surgery available in the UK. The collection of evidence that illustrated the demand for the procedure was reported to have resulted, in part, in the NHS to offer the surgery by interviewees.

## Licensing

No commercial licences had been secured since completing the ICURe programme, although discussions are in place, as described above, to secure a licencing deal with a lifetime value of £50,000 over a 2-year period. In addition to untimely illness and the need to fulfil the research contract with the NHS subsidiary, two key challenges were raised that may have made it difficult for the team to secure a licence:

- **Importance of ECR personal connections:** Through the exercise, the ECR had put the most effort into developing a relationship with the targeted tissue bank. Now that they are no longer actively supporting securing a licencing deal, personal relationships with the bank need to be rebuilt by other project team members – this is likely to have caused delays securing any deal.
- **No resources available to support focused development:** After the project completed the programme, no additional resources are made available for an ECR to support developing licencing deal opportunities. This made it challenging to develop relevant opportunities, as supporting activities are completed around other academic commitments.

## Spinning out

A spinout was not pursued since the completion of the programme as the team was focused on securing a licencing deal.

### Wider impact: Individual Outcomes

Several changes were reported at an individual level for the ECR and PI:

The ECR reported they did not hold previous experience in market validation or sales activities prior to the ICURe programme. As a result of participation, the ECR highlighted two key benefits:

- First, the ECR developed business and inter-personal skills, through a combination of theory and practical experience.
- Second, it made the ECR consider the potential commercial traits of R&D activities. Although, these experiences did not result in any change in the wages of the ECR.

In addition, the ECR highlighted that the ability to work closely with a range of individuals and travel more regularly to secure business opportunities were appealing traits of a professional career. As a result, participating in ICURe was said to have made the ECR realise they wanted to pursue a career in business rather than academia.

### Wider Impact: Institutional Outcomes

Overall, the project did not have any immediate effect on the culture of commercialisation within the department at the HEI. A key challenge cited in changing the culture was the department's reported perception that publication activity was more important for the upcoming REF exercise than supporting commercialisation activity.

### Attribution

The key mechanism through which this project is expected to achieve its intended impact is through licensing the technology to a large US tissue bank, although discussions are still underway to secure a deal. The case highlights that the decision to license the technology had already been made prior to the start of the programme but the exercise did provide strong validation for the strategy, and provided a more detailed understanding of the market for the technology.

The case also identified the following contextual factors that facilitated the programme Theory of Change to operate as presented in the evaluation plan:



- **Historic positive PI relationship:** In addition, interviews with the project team highlighted that the ECR and PI had a positive professional relationship developed through previous research projects, which may have influenced the type of support received by the participants - for example, the PI did not attempt to lead the market validation exercise but considered the ECRs views seriously and provided constructive feedback.
- **Informal mentorship:** A speaker at the Bootcamp became an informal mentor for the ECR, because of their interest in supporting women pursuing careers in business. The mentor provided some limited support to the ECR over the course of the programme – for example, guidance on how to develop and deliver the Options Roundabout presentation. While this mentorship is unlikely to have been provided in the absence of the programme, the support is over and above what is typically provided by the programme.

Without considering these other factors, the changes recorded that are attributed to the programme may be overstating its effect.

## Case study 2: Commercialisation and impact of the User Driven Interaction in Augmented Reality (User DIARY library)

### Summary

The Digital Media Technology (DMT) Lab, situated in Birmingham City University, received £31,336.11 of funding from the Midlands ICURe A (14) cohort from June to September 2018 for the project titled User Driven platform for Interaction in Augmented Reality (User Diary). The funding was key to driving forward the technology developed by the Mixed Reality and Human Computer Interaction (HCI) Group, located in the DMT Lab. The group specialises in natural interaction systems (HCI) for Mixed Reality (MR), Augmented Reality (AR) and Virtual Reality (VR). The research focused on enabling the MR/AR/VR user to manipulate virtual objects, seen through smart glasses or a head mounted display, using their hands in a similar way to manipulating real objects. While, the group had validated the technology underpinning the freehand interaction models within a lab-based setting, such models were not yet commercially available. The ICURe funding provided a unique opportunity to consolidate research outputs and transition the technology from prototype to a commercially adoptable solution for the development of industrial MR/AR/VR systems that require or would benefit from improved natural interaction. Although, it should be noted that at the time of application the team were unsure as to whether licensing, spinning out or both licensing and spinning out were the main objective for the route to commercialisation.

The research team received positive and actionable feedback following the Options Roundabout, however, they did not receive additional funding. Although productization of the technology was the main focus of the team, during the Options Roundabout presentation the ECR unintendedly emphasised patent protection as the primary goal with productization not being emphasised enough for the panel of experts. This miscommunication prevented the allocation of additional funding. Nevertheless, as a direct result of ICURe the university has invested c.£60,000 to employ two software developers to support the research team productise the technology, as well as committing to covering the associated patent fees. Therefore, the research team have decided to pursue a dual approach to commercialisation in the form of patent protection and productization of the software library technology. Furthermore, the research team has successfully received Innovate UK funding for one Knowledge Transfer Partnership (KTP) and is awaiting the decision on a further two applications. The KTPs will allow the team to work with businesses, identified through the ICURe process, over the next 12 to 24 months to embed knowledge relating to the technology into the companies' practices and processes. In parallel to the KTPs the researchers and software developers, once appointed, will drive forward productization and patent protection application process, although the exact timescales for this are still unknown. While the DMT Lab promotes the development of end systems, ICURe has directly allowed the team to identify four clear routes to market, to secure further public funding through the Innovate UK KTP programme, and harness additional internal investment to support productization. Furthermore, outputs generated through ICURe will be integrated into the university's REF2021 submission.

### Background

The Digital Media Technology (DMT) Lab, situated in Birmingham City University specialises in the development of methods for creating, processing, analysing, evaluating and distributing digital media, across four core themes:

- Mixed Reality and Human Computer Interaction (HCI)
- Digital Image and Video Processing
- Digital Audio Processing
- Digital Media Distribution

The ICURe application focused on the research undertaken by the Mixed Reality (MR) and Human Computer Interaction (HCI) Group. The group specialises in understanding and defining new methods and modes of interacting with computer systems via new sensor systems and current MR, AR and VR hardware. The group also researches the methods for improving

the application and adoption of MR, AR and VR systems into production workflows and holds a core specialism in understanding the usability and plausibility of the end systems.

Over the past eight years the group has and continues to develop a wealth of internationally outstanding work detailing experiments and developments relating to natural interaction systems for MR, AR and VR. Research has focussed on enabling MR/AR/VR users to manipulate virtual objects using their hands in a similar way to manipulating real objects. For example, allowing a user to hold, reach or grasp a virtual object augmented into a 'real-world' setting. The virtual object can be seen by the user through smart glasses or a head mounted display such as, Hololens, on the screen of a tablet with a rear facing camera, or on a monitor screen displaying the output from a separate camera.

The group consists of a core team of academics who are part of national and international committees (ISMAR) and interest groups (ImmerseUK) in AR, VR and work with some of the world's leading international companies in developing novel AR and VR solutions. The group further works in conjunction with leading UK charity organisations in researching novel interfaces and hardware solutions for users with physical impairments. The Principle Investigator (PI) of the ICURe project has been leading the research area for the last eight years, managing and working with PhD students and Early Career Researchers (ECR) as well as other academic staff and industry researchers.

At the time of application, freehand interaction models were not commercially available with prototypes being validated in laboratory conditions only, making the project novel, state of the art and timely. MR, AR and VR technology had matured (and continues) to mature to a level where reliable consumer-devices are becoming available. Many of the traditional barriers to MR, AR and VR adoption, such as hardware costs, rendering realism and tracking robustness, have been negated. However, usability and interaction barriers are still preventing applications from expanding outside research laboratories into wider industry adoption. The research team recognised that MR, AR and VR, alongside machine learning and artificial intelligence (AI) are some of the key building blocks required to create the digital transformation required across industries worldwide. Furthermore, freehand interaction models, if successfully exploited could markedly increase productivity across multiple industrial domains including, but not restricted to, manufacturing, engineering, education and health.

At the point of application, the research team had already amassed a wealth of high quality international research outputs and felt the next step for the technology was commercialisation. The project titled, User Driven platform for Interaction in Augmented Reality (User DIARY), aimed to consolidate the DMT Lab's laboratory-based outputs into a commercially adoptable solution for the development of industrial AR systems that require or would benefit from improved natural interaction.

Prior to ICURe the university would generally develop underlying technology and test prototypes in a laboratory-based setting before scoping the market to see where the technology might 'fit best'. This meant that technology was frequently developed before the market had been fully identified, engaged or validated. Meaning that technology was potentially being shoehorned into an area that might be receptive to the technology without understanding the gaps and needs of the market first. ICURe provided the research team with a rare opportunity to identify the key markets, validate the market and develop the technology based on need, while also developing strategically important partnerships. It should be noted that at the stage of application the TRL was 3 (Analytical or experimental, proof of concept confirmed) and at the point of contact during the survey the TRL was 4 (product validated in software development environment). At the point of application, the team were unsure of the exact route to market and wanted to use ICURe to further understand whether IPR, spinning out or both was the most effective pathway to commercialisation. Team members noted an element of naivety regarding the process, which can in part explain the lack of clear intentions regarding commercialisation at the point of application.

## Application to ICURe

The ICURe grant funding opportunity had been identified by the internal grants application team and circulated to all research groups. At the time of application, Birmingham City University had not previously applied to ICURe. However, ICURe afforded the team the opportunity to bridge the gap from research prototype to industry ready technology that would be relevant across a number of industry domains. The DMT Lab, specifically the Mixed Reality and Human Computer

Interaction (HCI) Group, had been involved in a number of collaborative partnerships assisting companies to drive forward technological innovations, primarily through Innovate UK funding. However, ICURe was the first funding opportunity the university had found that primarily focused on the development of business models, market validation and business planning of the underlying technology they had developed. This was key as the technology had been validated in a lab-based environment and required funding and resource to explore the potential for commercialisation and exploitation. In particular, ICURe had the potential to support the research team to identify and understand:

- Where the greatest opportunities for the technology were
- In what form the technology should be packaged in order to make the biggest impact
- Where, and from whom, the technology could be most useful

Birmingham City University are an applied university and seek opportunities to engage with industries in order to make an impact in 'real-world' settings. Having an applied approach to research forms the foundations of the REF2021 submission. ICURe had the potential to maximise and drive forward the strategy of developing theory into sustainable and efficacious practice suitable for industry. The Mixed Reality and Human Computer Interaction (HCI) Group were in a position to capitalise on this opportunity and it was decided that the research team apply for the funding. It should be noted that the university did not have any pre-selection.

Broadly the team had been working together in some capacity for two years prior to the ICURe application, making the formation of the research team relatively straightforward. The Principle Investigator (PI) had at the time been leading the research area for the last seven years, as well as having substantive industry experience. The ECR had joined the research team in 2015 and was actively involved in developing the underlying technology and was ready for further development. The business advisor had extensive industry experience, working for Google, Motorola and Aris prior to being appointed Head of the School for Computing and Digital Technology at Birmingham City University. However, the team sought the support of an additional business advisor once it had become apparent that the Head of School was unable to provide the time required to support the project. The University of Warwick identified a new business advisor with the capacity to support the team more intensively, although the Head of School continued to provide ad hoc advice and guidance. The Head of Innovation and Entrepreneurship within the university provided the extant industry experience and grant application knowledge required to be appointed the Technology Transfer Officer (TTO). It should be noted that throughout the ICURe process the TTO had a light touch role providing high level advice and guidance, however the team felt that the support offered by the business advisor and Head of School was more than sufficient.

Key motivations and drivers for individual involvement included:

- Prior links to industry i.e. individuals who had worked in or with industry understood the benefits of developing prototypes into commercially viable products
- Having an interest in seeing the underlying technology improve training and enhance productivity
- The need for universities to function as businesses (the changing landscape over the last 10 to 15 years)
- The need for universities and academics to create outputs that have an impact outside of academia (application of outputs in the 'real-world') in order to harness future investment and enhance reputation, through REF2021
- Career development
- Reputation, from an individual, research group, school and university perspective

The ECR led the application process with 'mentor-like-support' from the PI and the business advisor, with little or no assistance from the TTO at this stage. All team members had experience of completing grant application forms, while, the business advisor brought additional knowledge and experience of developing business models or cases, carrying market validation exercises and developing business plans. The research group already had strong internal links, however, the application did raise the profile of the research area internally. At the point of application, the research team indicated that the project and ECR had a level of naivety relating to the realities of commercialisation and the route to market and how this linked to the requirements of ICURe. This is not surprising given that the ECR had only ever worked within an academic

and research setting and was one of the key drivers for her involvement in the project (career development). Costs incurred to complete the application were ECR and PI time from the perspective of writing the application and the business advisor and TTO from a quality assurance perspective, although exact costs were not known. However, the ECR and PI estimated c.5 days of time in total to complete the application, this includes meeting with the business advisor to gain insights and thoughts and going through the internal quality assurance process before submission. It should be noted that at the time of application the team were unsure as to whether they would pursue IPR, spinning out or both, it was hoped that this process would provide a focus on what most efficacious path to commercialisation would be.

## Experiences during ICURe

### Four-day residential Bootcamp

The four-day residential Bootcamp for research teams, focused on forming a hypothetical business model for the commercialisation of the project together with a budget, action plan and topic guide/interview questions for testing the business model had been designed and developed. It should be noted that the first day of the Bootcamp was restricted to ECR's only. Bootcamp activities were facilitated through structured and formal lectures, workshops consisting of self-directed study, interactive activities and group work. Lectures took place in the morning in which theories and knowledge of what activities need to be completed and how and why. In the afternoon, through interactive activities, ECRs were provided with supported opportunities to apply the theory and knowledge from the lectures to develop workable business models and actions that were to be implemented over the next 3 months and ultimately feed into the Options Roundabout.

The business advisor and PI expected the Bootcamp to be intense, challenging but hugely insightful, especially for the ECR who had little experience, at that time, of generating business models, developing market validation activities or considering routes to market. The ECR indicated that heading into the Bootcamp, she had a level of naivety as to what needed to be done in relation to developing a business model, developing an action plan and budget for market validation and actually delivering on those activities. Despite the intense and challenging nature of the Bootcamp, the skills and knowledge gained with support from the research team, Warwick University and the support offered from other attendees was invaluable.

The Bootcamp provided a unique opportunity for attendees to network, which was useful given that members of other universities had varying levels of knowledge and experience of industry, commercialisation and the ICURe process itself. In addition, projects were at different stages regarding licensing and patent protection with some research teams securing Intellectual Property Rights (IPR) prior to the Bootcamp and others were still considering the options and opportunities around IPR. Again, this provided the ECR with useful insights on the licensing approaches taken by different research teams and why particular approaches were chosen.

Overall, the Bootcamp was received positively by the ECR, PI and business advisor. The ECR gained a myriad of ideas, skills and knowledge, as well as a detailed three-month action plan. This stood the project in good stead for the subsequent market validation processes conducted over the next three-month period. The Business Model Canvas was useful in identifying the scale and scope of the path to commercialisation. Initially three key channels and segments were identified as 'viable interfaces' for the technology. These were users, software developers and hardware developers. As the Bootcamp progressed and the ECR identified an opportunity to broaden the scope of a project to target a new segment focusing on consolidating the team's developments to create software libraries. Within the key channels and customer segments the ECR highlighted that the project team would need to engage with existing industry partners as well as scoping opportunities to collaborate with new partners across industries to successfully validate the market. In this respect the Business Model Canvas provided the research team, and particularly the ECR, who was the driving force behind the project, an overview of (this had previously not been completed by the team was deemed as extremely useful in focusing the direction of the project):

- Who the key partners were
- What were the key activities that needed to take place and the associated resources
- What the potential value proposition of the technology was across industries

- Who the key customers were (what were the segments), the relationships with those customers and the channels in which to reach them

The action plan then provided the necessary information outlining the activities required:

- Identifying businesses and partners within the four segments identified
  - Who the businesses were
  - In what segment(s) did they fit
  - Where they were based
  - What the value proposition be for that business
- Conduct interviews with businesses
- Contacting and engage with businesses
- Analysis the data from the interviews
- Understand how best to 'package' the technology and identify the best route to market
- Prepare for Options Roundabout

The action plan activity enabled the ECR and the wider research to narrow the focus on key activities that would be essential to understanding the path to commercialisation. In turn, this allowed for the development of an extensive budget to support the validation process. The ECR noted that these activities were very new to her but invaluable to the process and developments that have continued post ICURe.

### Market validation activities

The research team, led by the ECR with support from PI and guidance from business advisor highlighted four segments in which to identify businesses:

- AR Early Adopters
- AR Potential Industry Adopters
- AR Manufacturers
- AR Development Companies

The ECR identified existing businesses that the university already had working relationships with, as well as searching websites such as LinkedIn, completing google searches, searching directories, and snowballing i.e getting other/following on contacts from businesses that had been engaged. In total 115 businesses had been engaged in market validation across 6 countries:

- China (15 companies)
- Spain (7 companies)
- Germany (9 companies)
- The Netherlands (9 companies)
- USA (45 companies)
- UK (30 companies)

In addition, the ECR attended 5 events:

- EdTechXEurope
- TECHSPO
- Mobile World Congress
- SPIE Optical Engineering + Applications
- AD:Tech Kansai – KOBe

Over the 3-month period following the Bootcamp the ECR travelled to each of the countries to conduct face to face interviews with businesses, as well as engaging in informal networking at the 5 key events. During the interviews, the questions generated during the Bootcamp were used to gather the information required to understand:

- the key/immediate and longer-term opportunities
- where the technology would be most useful and in what form the technology should be packaged

Following the interviews, the research team analysed the data and decided that there was a case for productising the technology, most likely in the form of solutions-based software libraries. In addition, the team identified areas of the technology that would benefit from patent protection. Again, the process was reviewed as positive, insightful and providing the direction and validation required to confidently start the commercialisation process. In particular, this exercise enabled the research team to understand what the different industries wanted in terms of application and specification. The business advisor previously indicated that there is often a mismatch between perceived requirements (assumed by academic researchers) and the actual requirements driven by industrial demand.

## Options Roundabout

Preparing for the Options Roundabout enabled the team to narrow the scope of the project and understand, based on evidence from the market validation activities, the most optimal direction of travel for the technology. Based on evidence from the 115 interviews and 5 events the research team decided that:

- the software should be productised into software libraries
- patent protection for underlying technologies should be sought

The presentation was designed to focus on two paths to commercialisation with an emphasis on productization and patent protection, with productization being the primary goal. However, during the course of the presentation, it appears that the ECR emphasised patent protection at the detriment of 'pushing productization'. This meant that the panel of experts perceived patent protection as the primary focus for the team. As a result, the team did not receive following on funding, although the team were extremely positive about the whole experience and will, when in a position to do so, apply for ICURe again and promote the programme internally across other research centres. Nevertheless, the feedback from the expert panel was extremely positive and provided the affirmation the team needed that the project had potential. The exact advice could not be recalled, but the panel emphasised the need to productise the software. The ECR and business advisor indicated that the ICURe processes provided the team with knowledge and confidence that the technology could successfully be commercialised and that the combined approach of productization and pursuing patent protection was in fact the most effective direction of travel.

## Suggestions for improvement

The research team highly recommend ICURe and promote the programme internally but felt more could be done for other 'first-time' universities to find out about the programme.

## ICURe Commercialisation Impact

Although the team were unsuccessful at the Options Roundabout and did not make substantial progress, investment has been made since ICURe and can, in part, be attributed to ICURe. ICURe provided the team with confidence that commercialisation was viable. Evidence generated through ICURe has been used to secure internal investment from the university to:

- Employ two new software developers to support the research team to productise the technology in the form of software libraries – c.£60,000 including on costs

- Register a number of patents – applications are currently ongoing which can cost c.£300+ per patent although figure varies based on specific requirements

The development of the software libraries is a priority for the research team, however the exact timescales for development and commercialisation are unknown.

In addition, based on the new collaborative partnerships forged as a result of ICURe, the research team and respective partners have applied for 3 Knowledge Transfer Partnerships (KTPs). One KTP application has been successful and the other 2 are currently pending. The KTP funding will allow the research team to work with identified business partners over 12 to 24-month period to transfer the knowledge, skills and technology developed by the team into the day to day operations of business partners with an aim of increasing proactivity and profitability. Running in parallel to this the team with support from the software developers were purposing productization.

## Wider impacts

### Individual outcomes

The ECR has gained a solid understanding of the process and recourses required to transfer research outputs from the laboratory to industry. Since ICURe the ECR has grown in confidence as well as knowledge and this has provided opportunities to lead applications and pitches. The PI and ECR have developed a number of new contacts and forged positive collaborative partnerships with businesses that the research team did not previously have, which has been the driving force behind the KTPs. The ICURe project has supported the ECR to accelerate her personal and professional development, as well as broadening the scope of her research from developing prototypes through to taking new technology into the market.

### Wider impact: institutional outcomes

The university takes an applied approach to research. Nevertheless, commercialisation is generally driven by individuals within the institutes with a particular interest or background in industry. The ICURe project has reinforced the potential benefits of making end solutions that are or will be market ready. The impact that will be generated through the KTPs and the subsequent productization will be integrated into the REF2021 submission.

### Attribution

The changing culture of the HE sector from academic institutes into profitable businesses requires universities to broaden their scope from 'research for research's sake' to impactful outputs that effect positive change across industry. In addition, REF 2021 is designed to build a culture of impact research and requires universities to submit case studies evidencing impact of outputs. The ICURe project and the activities that have occurred since support the universities wider agenda for generating knowledge, skills, impactful research and investment. Research outputs developed as a result of ICURe, such as the KTPs will be integrated into REF 2021 case studies.



## Case study 3: Towards a commercial system for electrical control of gene expression (Cytecom)

### Summary

This Warwick university project went through Cohort 10 of the ICURe programme. The technology under development sought to help businesses and academics control bacteria in industrial processes and R&D. The team was without a Business Mentor until after the programme was completed due to recruitment issues.

The programme was effective in preparing the ECR to lead on the market validation exercise. The exercise identified that the team had originally focused on an application that did not meet a clear business need. The project pivoted towards detection of bacteria (rather than control) and secured more interest as a result. The team started a spinout with approval from the Options Roundabout panel and secured AFSU funding (despite some initial delays in confirming funding). The spinout is about to launch two products to market, which are in the process of being patent protected. Without ICURe, the project would have likely achieved a spin out but at a much slower rate, due to limited TTO and financial resources available at the time.

The case identifies the importance of securing support for the programme from a PI at the application stage. Without early support, projects with high quality proposals may not even submit an application. This means more could be done to incentivise PIs to take part in ICURe – for example, by identifying how ICURe could support PIs to meet their own performance objectives. This was mitigated in this case by using other university funding sources to cover the cost of the ECR whilst on the programme and enabled the teams to draw on university R&D resources to complete additional validation and testing – a factor thought to be critical in supporting the project pivot.

### Background

The technology underpinning Cytecom was an application of synthetic biology that sought to design, make and manipulate molecular material such as bacteria, enzymes and DNA. Initially, the project had a broad focus on understanding the extent to which molecular material could be created synthetically. Early versions of the technology were developed through a basic science project funded by a proof of concept fund administered by the university. The project had been delivered for about two years before an application to ICURe was submitted, and was directed by a PI, primarily managed and delivered by the ECR, and supported by a laboratory technician.

#### Initial R&D Activity

After one year of delivery, the basic science project's scope narrowed to become more focused on the use of electronics to communicate with bacteria. In basic terms, the technology is a set of electrodes that create an electric field. This electric field is then set at a specific frequency which is able to control the membrane potential of bacteria inside this field. A bacteria's membrane potential is responsible for many physiological processes, such as their growth rate or gene expression, which provides a degree of control to the user.

Prior to participating in ICURe, the ECR thought this ability to control the physiological processes of bacteria had commercial potential - for example, by influencing the growth rate or florescence of bacteria used to synthesise chemicals, or define the proportion of different types of bacteria present in a reactor used for fermentation. However, no attempts to commercialise the technology had been made prior to ICURe. While the ECR and PI had informally discussed potential commercial applications of the technology with university colleagues, no industry representatives had been consulted about the technology.

Prior to ICURe, the main challenge and focus of R&D efforts was developing the proof of concept into a commercially viable product. Project interviewees were asked to estimate the value of additional R&D required but refused to respond, citing a high level of uncertainty associated with the amount of resources required at that stage.

## University Commercialisation Support

The university has a process in place that academics follow to disclose technologies and research outputs with suspected commercial potential to the TTO. An academic is required to flag a technology to the TTO. An officer is then assigned to the technology to review it in more detail. A number of steps are then taken to progress the disclosure:

- **External review of the technology** by an external organisation to understand and validate the extent to which the technology is unique (i.e. freedom to operate) and commercially viable (e.g. market analysis).
- **TTO funding available for supporting activities** such as patenting and licensing, which could be used to support the development of a technology. Access to this funding needs to be approved by an internal board. For example, in this case, a budget for supporting the patenting process was secured by the TTO.
- **Marketing activities** using internal and external online communication tools. The aim of this activity is to attract potential partners (typically to license) and investors (to fund development).
- **Desk research** completed by the TTO to understand the commercial potential of the technology and the extent of any competition. In the case of any expected spin outs, this could support business planning activities and the recruitment of an executive management team, drawing on existing lists of contacts maintained by the university.

This project was reported to be a typical project that the university would support. However, the TTO highlighted that the enthusiasm and motivation of the ECR was higher than average when a new disclosure was filed, which was said to make ICURe more appealing in this case.

While no pre-selection process for ICURe was administered by the university, all ICURe applicants must have had their technology registered with the TTO beforehand, so that the TTO has oversight of applications. The university has not prevented anyone from applying but it was reported that all projects that attempted to submit an application were thought to be of a sufficient quality.

## Application to ICURe

The ECR held x years' previous experience working in a spinout company created as a result of a different project at a different university. This experience increased the ECR's knowledge and understanding of other means to increase the impact of basic research, beyond publishing journal articles – especially an awareness of funding made available to support commercialisation by universities. As a result, the ECR proactively sought guidance from a university TTO representative, who identified ICURe as an appropriate programme to consider. The motivation to apply for ICURe was underpinned by the ECR's interest in understanding the market needs for controlling bacteria in industrial processes. This motivation was fully supported by the PI of the basic research project.

The team put forward held limited commercial expertise and experience. The ECR and PI from the original basic research project were included in the prospective team. While the ECR held some commercial experience working in a spin out, the PI's experience mainly focused on the delivery of academic research. The TTO representative that was initially contacted was included in the team and held experience in securing licencing deals, but none in supporting spin out activity.

The project failed to identify a suitable business mentor until after the ICURe programme had ended, using their university's register of mentors. The project team found it challenging to find a mentor with appropriate skills, with the ECR highlighting that some project teams may not have submitted an application if they could not secure one. This highlights the potential need for more support from the programme in sourcing mentors, for example through a meetup or matchmaking event. Previous ECRs were suggested to be useful candidates for mentors on future programmes because of their recent and relevant experience.

The application was prepared by the ECR. Interviewees estimated that the written application took four FTE days over a two-week period to complete and indicated that the time taken to prepare it was proportionate to the funding and support made available by ICURe. In fact, the application process was considered to be far less bureaucratic than other funding sources made available by the university. It also provided a useful mechanism to reframe how the technology was presented to audiences with interests in commercialisation and exploitation.

The ECR and PI held several meetings to discuss how best to present the technology in the application and at interview. The technology and ICURe application was also supported by the TTO officer in several ways, accounting for about two days of their time in total:

- **Reviewing application drafts** to make it more appealing to ICURe reviewers – for example, by toning down the technical traits of the technology while emphasise the commercial potential of different industrial applications.
- **Identifying other funding sources** to provide assurances to the PI that they would not lose resources on their research project should the ECR secure a place on the ICURe programme
- **Patent support** to help the project register IP by commissioning a freedom to operate and market analysis study and lead on the administrative patent registration processes.

The ECR reported that their enthusiasm and motivation to become involved in commercialising the technology was a key determinant of being accepted onto the programme - interviewees stated that a small number of ECRs and academics were interested in commercialisation, meaning they stood out – although ECRs with commercialisation interests were said to have increased in recent years.

## Experiences during ICURe

This subsection provides an overview of the Bootcamp, market validation and options roundabout activities, completed as part of the programme.

### Four-day residential Bootcamp

Participation in the Bootcamp was reported as very effect by project team survey respondents. The case highlighted that this was because of reasons focused on increasing the confidence of the ECR in engaging in commercial activities:

- **Increased ECR confidence:** A number of exercises sought to make academics feel more comfortable and confident when talking about their technology with new audiences. Exercises included developing a two-minute commercial pitch and exercises that forced ECRs to use specific language when pitching the technology.
- **Development of ECR peer networks:** ECRs that met during the Bootcamp were then able to share advice and support as the market validation was underway. Especially as many ECRs were completing regular long-distance travel.
- **Identified the need for different communication strategies:** The interpersonal skills required to market and sell products were said to be different to those required to discuss research in an academic setting in interviews. The Bootcamp taught several different strategies to support ECRs adapt their existing communications styles for the validation exercise. These included focusing on market applications (rather than performance traits), using clear, non-technical language and engaging potential customers in an energetic and enthusiastic manner.

While action planning and sessions on entrepreneurial theory was informative, the simplified version of the business model canvas, that focused on understanding business needs and possible solutions, was most useful for the ECR. This tool was effective because it focused the team on the commercial uses of the technology rather than its underlying technical traits in a clear way. While the standard business model canvas was helpful, its complexity was said to distract project teams from

the basic need to refocus on understanding, and responding to, business problems. Especially given that many academics on the programme were said to be new to entrepreneurship and may be overwhelmed with a large set of new concepts.

The PI and TTO officer attended the Bootcamp for one day. For the PI, the sessions highlighted the need to let the ECR lead the validation exercise, which the PI was supportive of - partly because the ECR and PI had developed a positive working relationship through previous research projects where the ECR was permitted to work independently without being overly micro-managed.

Whilst the university has had projects complete the ICURe programme previously, the assigned TTO officer had not supported one before. As such, the Bootcamp was said to be a useful overview of how the programme operates and what support is required from the TTO team member. In a Bootcamp session for TTOs, the TTO officer found it useful to understand what the expectations were for how the team should prepare a budget and action plan. Without that session, the TTO suggested that signing-off a final budget for the validation exercise would have been more challenging and taken longer to achieve – for example, this session provided guidance on how to take part in ICURe while satisfying the requirements of central university finance teams, that typically do not deal with funding allocated through expense claims.

### Market Validation Exercise

During the market validation exercise, the ECR primarily made new contacts by attending relevant conference events, because of the perception that these events were a quick means of generating new contacts. In this case, interviewees highlighted this approach was effective because industry representatives at conferences are already interested in making new connections, which made the process less daunting than developing contacts through other means such as cold-calling. The project initially made contact with those organisations in the fermentation science sector, especially those involved in chemical production and those that used industrial processes with water-borne bacteria.

The market discovery exercise fundamentally challenged the team's original views about the commercial potential of the technology. Initial industry discussions identified that manipulation of biological material did not have immediate commercial potential. Instead, the exercise highlighted a need for detecting the presence of bacteria at different stages of the production process. For example, in the case of a fermenter making chemicals, industry representatives said they had a sufficient level of control over the bacteria they were using, but faced difficulties in detecting bacterial contamination.

As a result, the ECR attended more conference events about bacterial detection, and received much more commercial interest from potential customers. Fortunately, the technology already had the ability to detect if bacteria was present (alive or dead), as this is a precursor step to manipulating bacteria. Some additional testing was completed to understand if the pivot was possible, which was completed by the supporting technician at the university, who was working on the academic research project in the ECR's absence.

Support from other team members was limited but focused and now views were provided on the effectiveness of any support provided by ICURe delivery staff. The PI managed the completion of complementary R&D to support the pivot; they were the main point of contact for the ECR while the exercise was underway. The PI was supportive of the pivot and was said to encourage the ECR to develop their own conclusions about the results of the exercise, independently of their own views and ideas. The TTO supported the validation exercise in a limited capacity by supporting initial logistics planning (such as drafting emails and telephone scripts to potential customers and planning travel), continuing to administer the patent registration process and source potential funding opportunities for the project. As the exercise progressed, the TTO provided less support, but increased support offered as the exercise came to a close in order to support the synthesis of results and plan for the Options Roundabout. As discussed above, a Business Mentor was not in place until after the ICURe programme was completed.

### Options Roundabout

Overall, the Options Roundabout provided the team with the validation it needed to feel confident that attempting to spin out the technology was appropriate. The ECR led on developing the presentation and the PI and TTO reviewed content

produced and provided encouragement to the ECR that the strategy selected was suitable - For example, the TTO officer organised for the ECR to practice their presentation by delivering it to the university's associated VC fund, which provided useful and objective advice on how to make the presentation clearer.

The Options Roundabout panel and the project team agreed that the project should spin out and the following discussion at the panel provided focused guidance on how a spin out could be funded, and what the most appropriate business model was.

## Suggested Improvements

The table below provides a summary of suggested improvements for the programme which are discussed in the report body.

Table 1.1: Mapping within-case findings to suggested recommendations

Programme design	Finding	Recommendation
Mentor recruitment	Project team faced challenges in recruiting mentor with relevant skills when they needed one.	Create an activity to support mentor assignment, e.g. matchmaking event.  Nominate previous ICURe ECRs as mentors, given their recent and relevant experience.
	PIs supporting ICURe projects may be more likely to support entrepreneurship than those that do not – which may prevent high quality ICURe proposals being submitted.	Promote ICURe to PIs by identifying the how it aligns with performance objectives relating to impact / negates concerns that it reduces publication/citation activity.
HEI funding for complementary support	The project's success was dependent on the availability of HEI funding to compensate ECR resource forgone by PI and support additional R&D during the validation exercise. Without funding PIs may not support the programme and complementary R&D cannot be funded.	Consider enabling PIs to drawdown funds to resource forgone ECR positions as part of the programme, instead of relying on other sources of university funding (e.g. Warwick Ventures) which may not be available at all HEIs.
	In this case, the university TTO guarantee the ECR salary for three months (via Warwick Ventures)	
Access to complementary support	The case highlighted that ECR resources after the programme finished were spent building networks of contacts that could provide complementary support – for example, testing and validation activities.	Consider providing an ICURe contacts list of approved contacts or organisations that could provide complementary services to ICURe participants and alumni.
AFSU administration	Uncertainties around the availability and administration of AFSU funding negatively affect project morale and timescales.	Ensure that AFSU availability and timescales are communicated clearly and accurately to projects.

## ICURe Commercialisation Impact

With support from the Options Roundabout panel, the project team decided to pursue a spin out after the programme concluded. The ECR was responsible for leading on this activity while the PI and TTO continued to provide a limited amount of support and encouragement.

No Aid-for-Start-Ups funding was made available at the time due to Innovate UK budget constraints, despite the Options Roundabout supporting an application for this funding source. This was said to be disappointing and frustrating by the team, who had worked under the impression that funding was available. However, when more funding became available three months (Q3 2018) after the programme had completed, the project was able to submit an application and secured £300,000, matched by £100,000 of investment provided by an SEIS/EIS fund based in the UK.

While no challenges were raised in relation to securing match funding once the AFSU funding opportunity was made available, the case identified several issues with AFSU:

- **Uncertainties supporting the project with funding** due to resource constraints and the ECR's academic commitments after the programme.
- **Delays in the appraisal and approval of funding** which delayed the start date of business development activities by six months.

At the time of interview, two patent applications (the first of which was a year old in Q2 2019) had been filed although these are not expected to be granted for a number of years.

## Non-commercial outcomes

The main focus on the project since the programme was completed was developing a spin out. While some additional R&D was completed to support further validation and testing, and the development of working products, these were secondary activities. No additional public funding was secured to support further R&D – additional R&D was funded by the university.

## Licensing

No commercial licences were pursued or secured since being awarded a place on the ICURe programme. This was because the project team were focused on spinning out the technology and ultimately launching their own product portfolio to market. However, as the university owns the IP (and the ECR is a listed inventor), the university licenses the technology to the spin out.

## Spinning out

The project technology has now spun out of the university and the ECR has taken a lead on managing the commercial aspects of the business. Although the PI is still involved in the technical R&D aspects of the technology, they are not directly involved in the day-to-day operations and commercial strategy of the business. As the university is a major shareholder in the spin out, the TTO officer is on the board of the start-up. This involves attending monthly management meetings and board meetings (scheduled every two months) to provide guidance to the spin out, and oversight for the university.

As the pivot achieved through the programme did not require any substantial changes to the technology, products are being launched to market much more quickly than they would have done otherwise (suggested to be up accelerated by up to one year). The spin out business has since developed two main products; one for R&D purposes and one for the broader commercial market. The R&D product line was being prepared for sales and marketing activity at the time of interview (Q2 2019) and the second product line was expected to be launched to market in Q3 2019.

A key focus at the time of interview was developing prototype products that could be used to support the ECR to complete sales and marketing activities. The ECR had developed a list of contacts as part of the programme that were interested in

seeing a product demonstration. Contacts included those from the bio-manufacturing, water and agriculture sectors as well as academics interested in using the product for R&D.

A key challenge in developing the spin out was the requirement to develop contacts and networks in areas that were complementary such as prototyping and testing. The case highlights a potential need to provide ICURe participants and alumni with suggested contacts to support follow-on activities, especially when completing business planning activities. Feasibly this could also include contacts for operational support like HR and Legal and draw on the experiences of other ECRs that had taken part in the programme.

#### Wider impact: individual outcomes

#### Wider Impact: Institutional Outcomes

The culture of the university towards commercialisation has changed as a result of participating in several ICURe projects and taking a lead on delivering a regional version of the programme. Three key changes at the TTO level were highlighted in particular:

- **Easing of resource burden on the TTO office:** The case highlighted that the university processes for supporting projects to commercialisation were well developed and systematic. However, a key challenge for the TTO office was reported to be a lack of resources to support all projects to a sufficient level and timeframe. The ICURe programme was said to ease the resource burden on the TTO by empowering motivated ECRs (who are interested in leading commercialisation activities) to complete activities that would have otherwise been completed at a slower rate by a TTO officer, many of whom have an ongoing portfolio of between 10 and 80 projects. In this case, the TTO officer assigned to the project was not able to travel outside of England to support the programme due to personal commitments. The ability of the ECR to travel to relevant conferences overseas was suggested to be a key additional benefit of ICURe that would not have been achieved otherwise.
- **Increased support for commercialisation:** As more staff have become involved in ICURe, the TTO office was said to have become more interested and proactive about supporting academics to commercialise their research – for example through encouraging academics to present their commercialisation efforts to TTO colleagues
- **Increased skills and capabilities of TTOs:** ICURe provided the TTO with more opportunities to support different types of projects. While it is common for a TTO to support a licensing deal, it was said to be less common to be involved in a spin out. As such, more opportunities to provide this kind of support has potentially increased the skills base of the TTO office, beyond which would have been achieved otherwise – for example, skills in marketing a technology and conveying key messages about the proposition succinctly.

### Attribution

The key mechanism through which this project is expected to achieve impact is through spinning out the technology, although all associated commercial benefits are not expected to be realised at this stage. The case highlights that spinning out was facilitated as a result of identifying how the team should pivot to better meet industrial demands for bacteria detection. However, the case also identified a number of contextual factors that have facilitated the Theory of Change to operate as presented in the evaluation plan. The key factors highlighted by the case include:

- **PI support for commercialisation:** Exploring the commercial validity of research outputs requires an ECR to leave their research post for a minimum of three months. Interviewees suggested that some PIs may view this as a 'counterintuitive disruption' to academic research, which is often measured by a set university publication and citation indicators. While PIs are said to be increasingly interested in commercial research impact (mainly due to changes in how the REF is compiled), interviewees highlighted that the project PI in this case was particularly supportive. The case finds that the creation of ICURe outputs was directly facilitated by the PI who supported the

objectives of ICURe and was open to their ECR taking time away from their research project. Without this support, the ECR may not have been permitted to submit an ICURe application, meaning no impact could have been realised.

- **Availability of HEI resources to support project R&D:** The availability of additional funding was shown to have facilitated the Theory of Change in two key areas: gaining PI support to submit an application and support the exercise, and enabling additional R&D validation while the validation exercise was being delivered:
  - **Securing PI support:** Providing assurance to the associated project PI that they would be compensated in terms of resources while their ECR took part in the programme was shown to be key in securing support to take part in the ICURe programme from the PI. Without these assurances, the PI may have been less willing to support an application or provide support to the ECR while the programme was being delivered.
  - **Additional testing and validation activity:** The availability of university funding to support additional R&D while the market validation exercise was underway seemed to be critical in enabling the project to pivot within the timescales of the programme. Without this additional funding, the project would not have been able to use technician resources to validate the technology's ability to detect bacteria. Without the production of additional test results, the team may have failed to secure sustained interest from industry contacts or Aid for Start Ups funding to develop a spin out business.



## Case study 4: University of Liverpool: Biodegradable Polymers/Plastics Synthesised by Free Radical Polymerisation

### Summary

This project was funded under the North and North West-A (NxNW-A) cohort of the ICURe programme, delivered by Queens University, Belfast. The project, which originated from the University of Liverpool, sought to explore the routes to commercialise a new technology platform which allows free-radical polymerisation to create equivalents of commercial materials, including commodity plastics/polymers, as well as new polymers, with targeted biodegradability features.

The team were advised to license the technology following their involvement in the ICURe programme. This conflicted with the aims of the team, and ultimately, they decided to follow the route of spinning out a company instead. The project has faced a significant barrier in choosing this commercialisation route and finding external sources of investment to form the spin out. Despite this, the project is continuing to refine its business plan and continues to source private investment to spin out. Although no direct commercial outcomes have been realised, individual team members and the University have reported wider outcomes which have been enabled through participation in the ICURe programme.

### Background

This project looked to develop a unique technology which allows free-radical polymerisation to be used from polymers comprising of step-growth backbone chemistries; this provides potentially biodegradable linking groups within polymer structures. This was created with the aim of creating a new platform which harnesses existing industrial processes to generate new biodegradable materials to address global material needs. In creating this new branched polymer chemistry platform which is compatible with current industrial processes, the project team are able to introduce a scalable and adoptable platform to large-scale multinational companies in the polymer manufacturing industry. Following a period of working in industry, this platform was developed by the Principal Investigator upon joining the University of Liverpool.

The project team had recognised the scope and potential value of the opportunity and the various potential exploitation routes to commercialise. More focus was required however, to create market insight and identify the most appropriate strategy to target high-value and quick-to-market products. Prior to their application to ICURe, the PI had approached five companies to gauge interest in commercialising the platform. Of these companies, two had expressed interest in developing the platform further and funded two technicians to help the PI develop and test polymer samples over a 6-month period. Despite receiving initial interest from these companies, nothing came of these opportunities. It was believed that the potential reason for this was that one of these companies did not have a 'champion' who was carrying forward this collaboration between the PI and the company. Further problems lay in not being given an accurate set of specifications with which they could develop the samples. During collaboration with the other company, polymer samples were tested and identified as having some application. However, these areas of application were in another department. The project then struggled to form new relationships with staff in this department and ultimately, nothing came of the opportunity.

The University of Liverpool has a relatively small and nascent Technology Transfer Office, having operated for only three years. As such the TTO is still in the process of building their processes. The technology Transfer Officer involved in this project outlined the steps taken by the TTO in engaging with projects with commercialisation potential. This involves organising a meeting with the academics involved, a review of the data generated to support their invention, an exercise to assess what further development is needed, a review of the patentability of said invention and what funding opportunities

are available to further progress the invention. When speaking with the Technology Transfer Officer, several enablers and barriers for inventions across different fields of application were raised. In terms of identifying the commercial opportunity for a given invention, examples were given of the ease by which health and life science inventions can do this, particularly as most would have some kind of clinical application. In comparison however, science and engineering inventions have a more diverse set of technological application opportunities with much less clear development pathways. Despite this, science and engineering opportunities are seen as having fewer regulatory hurdles to overcome in comparison to health and life science projects. In terms of the funding opportunities which are on offer, it very much depends on the field of application. It was raised that health and life science inventions have a flurry of translational research funding bodies available to projects looking to further develop the underlying research, including NIHR and MRC, whereas science and engineering projects have limited translational research funding opportunities available.

## Application to ICURe

The technology in pursuit of commercialisation was borne out of the PIs research programme, during which the PI had engaged with a third-year undergraduate at the University of Liverpool to progress his research and further test the potential feasibility to commercialise. Following this, the PI engaged with various companies with potential application for the technology platform to generate more data and to develop the concept more fully. Meanwhile, the ECR on this project had already engaged with the PI prior to ICURe as a post-doc, supporting the PI, although he had not supported the PI on this research project. The ECR and the PI saw the opportunity to commercialise the technology platform, with a focus on forming a spin out company. They then approached their Technology Transfer Office who then encouraged them to apply to the ICURe programme. The Technology Transfer Office had explained the direct benefits of applying to the ICURe programme, the foremost of which was the opportunity to leverage further funding which would help generate more data supporting the technology and identify market segments. These were raised as important steps in forming a spin out.

Speaking with the ECR on this project, they highlighted the added benefits of applying to the ICURe programme. Firstly, it was a good opportunity to solidify their involvement in the technology platform to a higher degree, particularly as he had not supported the PI in the underlying research. Secondly, the ECR outlined their interest in learning more about the business side to developing technology borne out of academic research. Hence, for the ECR, the ICURe programme was an opportunity to develop the entrepreneurial skills which the programme had to offer.

In terms of making an application, there were no internal preselection processes within the University. Rather the Technology Transfer Officer shared the project's initial plan with another team who had already been down the ICURe programme route previously. They were able to offer comments on the feasibility of the project receiving funding under the ICURe programme. Once the recommendation had been made to apply to the ICURe programme, it was the ECR which led the application. When speaking with the ECR, they felt that they were different to other ECRs applying to the programme, in that he had experience in writing applications like this before as he had already received grant funding through other programmes which followed a similar process. He found this to be an added benefit which other ECRs without much experience in this area might find challenging. The ECR wrote the draft and received feedback from the PI, business advisor and TTO.

Case study consultees highlighted numerous benefits resulting from the application process. Both consultees thought the application process was very informative and helped to clarify the purpose of the project and its overall vision. The Technology Transfer Officer was also very welcome of the application process being done online. When thinking about the costs incurred during the application process, those identified were costs associated with the staff time spent to draft and comment on the final application form. It was also noted by the Technology Transfer Officer that there is a very short

timescale from receiving confirmation that your application is successful to clearing three months of the ECRs diary to partake in the ICURe programme. However, this was not raised by the ECR.

## Experiences during ICURe

Case study consultees spoke positively about the different experiences comprising the ICURe programme, as well as the engagement from the different team members supporting this project.

Overall, the ECR felt well supported by all project team members. He found the input from the Business Advisor to be especially helpful in providing useful market contacts, as well as providing information on how to best approach meetings with external organisations/companies. For example, the ECR was advised to position business cards in the order in which attendees sat around the table, such that he could address them without having to necessarily remember the names of attendees. The Business Advisor had also taught him not to sell at people, but rather, to extract information from them initially, and once an opportunity to sell arises, to then take advantage. It was also from conversations with the Business Advisor that the ECR realised his elevator pitch approach at business fairs wasn't the best approach to sell his idea. Again, he was advised to listen to what companies were looking for and when an opportunity arose, the ECR would divert the conversation towards the technology platform. The ECR also found the PI to be sufficiently engaged in the programme and was always available when needed, as was the Technology Transfer Officer.

When speaking with the TTO, they disclosed their role during the programme, which included assessing invention disclosures, assisting with confidential disclosure agreements and assisting in setting up collaboration agreements with industry partnerships. Ordinarily, the TTO would also support the project in finding industry contacts, however, the PI already had an extensive network which he could draw upon for contacts.

### Four-day residential Bootcamp

The ECR spoke very positively about the Bootcamp activity strand of the ICURe programme. As the ECR had always been interested in the commercial side of translational research, they found the Bootcamp an exciting opportunity to exchange ideas and stories with other like-minded researchers. Seeing these attendees develop their elevator pitches throughout the day was also seen to be encouraging in observing first-hand the tools and technologies learnt throughout the day. The ECR also raised several other benefits of the Bootcamp:

- **Understanding the key factors which determine the approach to commercialisation:** the ECR believed those facilitating the Bootcamp were helpful in helping determine the right business approach, providing clarity in the focus of the technology platform, and, understanding of markets more generally. The ECR thought those which were facilitating were competent and confident in giving feedback on projects' commercialisation pathways and provided thoughtful suggestions of what and how to change.
- **Developing core tools used on the path to commercialisation:** the ECR thought the purpose of the Bootcamp was to set projects up with new skills and teach them how to use them practically. An example of this included developing an elevator pitch, which was viewed as useful in generating clarity around the sorts of key messages one would like to present when meeting with external organisations/companies. The project's Business Advisor had gone on to explain that the elevator pitch might not be the best approach at upcoming business fairs. Instead, the ECR was advised to listen to others and based on what they were speaking about, the ECR would tailor their pitch, such that these conversations felt more natural and free-flowing. Despite this, the ECR found the exercise of developing the

elevator pitch to be useful as it allowed him to think in more detail about what sort of information he wanted to get across to potential buyers/investors.

- **An opportunity for ECRs to fully understand the underlying technology and potential commercial routes:** When speaking with the Technology Transfer Officer, they raised that previous ICURe projects which they had supported had found the Bootcamp a useful opportunity for PIs to go through the programme with the ECR and think more carefully about what the next three months of activity would look like for the team.

The ECR did however raise that it was the first time the partnership running the North West programme was facilitating, and hence some parts were well organised and other parts less so. As a result, there was some waiting time between various sessions, and occasionally a lack of clarity in what was expected from attendees during each of the sessions. This was caveated however, with the fact that there were a lot of activities scheduled throughout the day.

### Business Model Canvas

The ECR noted that all project team members had a reasonable level of input into the business model. The output was viewed as a comprehensive hybrid of everyone's thinking which added clarity to the potential technological application which existed for the platform. The Technology Transfer Officer did however help to refocus the discussions on the potential investment opportunities. Upon reflection, the ECR thought that at the beginning the team were too broad in terms of the business model and market segment targeting. Again, it was raised that the Technology Transfer Officer redirected them to be more targeted.

### Market Validation Exercise

The ECR found the market validation exercise clarified the context and value of what they were trying to achieve through the ICURe programme. Much of what they had learned was something they didn't have any direct knowledge or exposure in prior to the ICURe programme. One feature of the Market Validation Exercise was to identify industry contacts whom they could approach and sell their platform to. The value of this however had been diminished somewhat by work previously done by the PI. As already mentioned, the PI had built up an extensive network of contacts across industry, some of which he had approached prior to participation in the ICURe programme. As such, the ECR found there to be some overlap in the companies which he tried to engage with during the market validation exercise, and in some instances found limited engagement from organisations to speak with him directly as they were already in talks with the PI of the project. Furthermore, the ECR thought the length of the market validation exercise – three months – was too short for building relationships with suppliers or companies. This was especially true for his project which had many potential customer segments which required investigation to determine viability. He recommended a longer period such that more robust relationships could be formed with these companies.

The ECR has highlighted the need for further support following involvement in the ICURe programme. He explained that now that he is back in his post as senior lecturer at the University of Liverpool and having not received further funding (the team have applied twice to other Innovate UK funding programmes – both unsuccessful), the project has lost some of its momentum as there isn't someone available full-time to drive it forward. As a result, the ECR would like an added feature to the programme which helps progress these ideas beyond the ICURe programme, should the outcome from the options roundabout not be to form a spin out.

The Technology Transfer Officer also highlighted a need for the project team to review the detailed panel decisions following the options roundabout. It was explained that this would help to better understand the reasons behind the advice.

The Technology Transfer Officer would also like to see more support or guidance from the ICURe programme when the outcome from the options roundabout is not to form a spin out. The Technology Transfer Officer was of the impression that once a licensing advice was given, the platform had reached a dead-end, particularly as their University had fewer clear guidelines on how to license a technology compared to spinning out a company.

## ICURe commercialisation impact

Following the options roundabout, this project was advised to license the technology platform. This conflicted with the aims of the project team members, all of whom would've preferred an advice to form a spin out. Furthermore, as a consequence of not being advised to form a spin out, the project was not supported for follow-on funding. After receiving their feedback, the team disagreed initially, despite the panel explaining that their application was too broad and didn't have a clear message. However, upon reflection, the ECR understands this comment after having seen successful applicants' products at a recent 'pitch day' hosted by the University of Liverpool, at which many of the NxNW applicants attended alongside industry players.

Following the outcome of the options roundabout, the Technology Transfer Officer highlighted the process by which they took the technology platform forward was similar to that of projects who received aid for start-up follow on funding. As such, the project team approached the EIF, indicating their need for an additional round of investment in order to engage a person to develop the business plan. The project has since received funding from the EIF and has also identified a CEO to approach and bring on board to develop the business plan. The project team are currently finalising their business plan before then going out to institutional investors. In addition to this, the university has also supported the project by funding two external consultants (one was a Business Advisor and one who worked in industry in one of the target market segments) to refine the business model in preparation for the ICURe pitch day. Despite this, the ECR feels that the technology platform has lost a lot of momentum, particularly as a lot of opportunities haven't materialised.

## Licensing and spinning out

This project was advised to license the technology platform to industry following the options roundabout. The team disagreed with this decision, highlighting the problems with licensing the technology:

- According to the ECR, he saw the ICURe programme as a gateway for further funding which licensing does not facilitate.
- Licensing was seen as too 'short-sighted', indicating the technology platform had numerous applications which could be better exploited through forming a spin out which could target more than one application area.
- The ECR also felt as though the platform needed more commercial development before licensing became a viable option. To do so, it was viewed that the technology needs to be refined in a commercial setting to determine the commercial readiness of the platform and the area of application which would be most suitable for licensing.

As a result, the project decided to progress commercialising the platform by attempting to form a spin out. At present, these attempts have not resulted in the successful formation of a spin out company. The team wanted to raise funding through additional Innovate UK funding programmes so as not to dilute the company too much initially, which would be the case had external investment been sourced; these applications were not successful. The ECR has highlighted the difficulty in continuing work on the platform as they and the PI are both occupied with existing responsibilities within the university. The PI and the Technology Transfer Officer have since reached out to potential CEOs to onboard onto the project to further

develop the business plan and take forward the pitch to external investors. Furthermore, the Technology Transfer Officer has spoken to a local investor who had encouraged them to apply to a devolved pot of Innovate UK money which is shared with a local VC firm - Midven. The VC firm is able to spend Innovate UK funds on investments so long as it provides matched funding to the beneficiaries. The outcome of this application is not yet known. The project has also sought investment from industry through participation in an ICURe 'pitch day' organised by the University of Liverpool for NxNW ICURe participants.

The ECR highlighted the problems encountered in trying to form a spin out. Paramount to this was the ability to leverage funding to form the spin out. It was noted that the university does not allocate much money to form spin outs, hence placing greater onus on external investors to propel the spin out.

## Wider impacts

### Individual outcomes

When speaking with the ECR, a number of individual outcomes were identified as having been enabled by participation in the ICURe programme:

- **How to spin out a company:** Many universities are capable of developing novel technologies through research programmes, but not many understand the nuances of identifying target markets, refining the product offering and speaking with external investors. The ECR indicated significant improvement in their ability to understand how a certain technology could be applied commercially through involvement in the ICURe programme.
- **Presentation skills:** the ECR highlighted a change in their ability to present with effect and with clarity.
- **Tailored approach to research programme:** Although the ECR could not recall any specific examples, they indicated that the ICURe programme has taught them to think more about their research plans and, where appropriate, build a commercial pillar into their work. It has "planted a seed" in their mind.
- **Ability to grow a commercial network:** The ECR provided two examples of how they have been able to grow their network through skills developed in their participation in the ICURe programme:
  - The ECR is currently involved in the Faculty Research and Impact team at the University of Liverpool. The team is responsible for providing high level support for academic research and impact activity, including Post-Graduate Research, by identifying and responding to opportunities, and working collaboratively with researchers to achieve their objectives. They provide advice based on previous experience, e.g. of funding applications and of the framework of internal and external policy surrounding this activity. The ECR noted that they will be organising a business industry engagement day for the university as part of his involvement in the Impact team.
  - Separate to the above, the ECR is also organising an industry conference at the University of Liverpool and as part of this has approached companies to become potential sponsors/attendees of the event, all of whom are contacts formed through relationships developed throughout the ICURe programme. The ECR believed their approach to encouraging companies to sponsor the event was also a skill they believed had been developed as a result of the ICURe programme.

## Institutional outcomes

The University of Liverpool has only recently engaged in the ICURe programme and consequently, there have been relatively few teams go through the programme. This was viewed as a potential cause for the lack of direct institutional change which might be expected from involvement in the ICURe programme.

Despite the ECR explaining there have not been any observable wider institutional impacts arising from the ICURe programme, the Technology Transfer Office has in fact begun to change its support mechanisms for researchers looking to commercialise their inventions. When speaking with the Technology Transfer Officer, they explained that they had worked for five other universities in the past and the culture with regards to commercialising research differs from university to university. For example, when they worked at Leeds University, there were 'well-trodden' pathways for commercialising inventions. The Technology Transfer Office at this university is relatively small and nascent however, having only operated as a team of seven for little over three years. However, since they're a small team, the Technology Transfer Officer believed they operate similarly to a 'start-up', which was said to remove a layer of bureaucracy which most universities face when supporting projects to commercialise their invention. This has however meant that the Technology Transfer Office has faced significant workload pressures in the first few instances of support as they have had to develop the processes and guidelines for supporting researchers. It was noted that the Technology Transfer Office has defined guidelines when forming a spin out, although the support mechanisms in place to help researchers license their technology is less developed.

The Technology Transfer Officer has since taken steps to further develop these support mechanisms since receiving the recommendation from the ICURe programme to license this project's technology.

Presence of the ICURe programme has also been pivotal in alleviating capacity within the TTO to support researchers. As mentioned previously, the University of Liverpool has a relatively small team. Hence, they have not got the time or resource to provide the types of support which the ICURe programme can offer, such as entrepreneurial training, customer validation exercises, etc. The Technology Transfer Officer explained their team's proclivity to recommend projects to the ICURe programme so that they can benefit from the various activities on offer which the TTO can't provide, or at least not to the same extent.

## Other

The Technology Transfer Officer coined the NxNW consortium as a 'band of brothers', formed because of the ICURe programme. It was noted that it has brought together universities across the north in a region which are now working closely together. There were several peripheral benefits associated with this, including building commercial networks, sharing TTO relationships and organising pitch days to help projects meet investors.

## Case study 5: City-scale high-resolution real-time flood nowcasting/forecasting and analytical solutions

### Summary

The project emerged from the Department of Geography at the University of Loughborough and looked to develop a prototype system providing flood nowcasting/forecasting with street level resolution. The team participated in the Mid-A cohort delivered by the University of Warwick and was composed by a Principal Investigator that had conducted research on the system for over 17 years, an Early Career Researcher, a Technology Transfer Officer and a Business Advisor who joined at the Bootcamp. Please note that this case study is based on interviews conducted with the PI and the business advisor only.

At the Options Roundabout, the team was advised to commercialise the project through a licence or a spin out. The team officially formed a spin out company in March 2019, in agreement with the University of Loughborough, with the Early Career Researcher employed full-time in the company and the Principal Investigator and TTO in the board of the company. ICURe was reported to have helped the project take the commercial route, enabling necessary processes to speed up the establishment of a spin out. At the time of interview, the team involved in the company, with the support of a CEO hired through the university, is actively engaging with venture capitalists and is close to sign the first contract. The team has reported that ICURe has been significant in raising the profile of the project and show its commercial potential, as investors are aware of the programme. Although the potential of the technology had been recognised before the participation in the programme, it has been suggested that ICURe helped speed the process up and make the potential more convincing and visible.

### Project Background and Context

#### Technology

The project is based on a system developed by the Principal Investigator over 17 years of research. The system consists of a two-dimensional flood inundation model capable of high resolution flood nowcasting (7 hours ahead) and forecasting (up to 48 hours ahead). The technology combines four elements: real-time rainfall nowcasting/forecasting products; real-time high-resolution flood modelling; real-time flood impact analysis; and novel visualisation techniques which allow flood footprints to be delivered to stakeholder organisations. The work has involved installing high-performance servers. The system is based on street level prediction, allowing emergency services and owners to make better decisions and decrease the response time during a situation of emergency. The technology was reported to currently cover 30 cities in the UK, to have been tested outside the UK and being readily scalable.

#### Vision on commercialisation

The research had been mostly driven by the Principal Investigator, who had been trying to commercialise the system since 2009 but encountering difficulties in finding the necessary investment from the university as the project didn't fall under the funding scope of the programme at the time. With recent changes in the University's Enterprise Office and the arrival of a new TTO in 2012, it was reported that the university started to encourage more frequently the commercialisation of projects through licensing and the formation of spin outs. The Principal Investigator was made aware of ICURe by the Enterprise Office at Loughborough but felt that it would have been challenging to find an Early Career Researcher who could bring forward the substantial amount of work he had been doing individually over the years. Before applying for ICURe, the Principal Investigator had no prior experience in establishing a new business or spin-out.



Before applying for ICURe, the Technology Transfer Officer believed the project had commercial potential and an interesting technology. However, it was not yet clear at the time (January/February 2018) what the opportunities were and how to realise that potential to bring the project to the market. The TTO had considered the option to licence to a software or forecasting company, but the option of a spin out was not yet considered. However, the team reported that prior to the application to ICURe, contact with some potential customers and partners had already been made. The Technology Transfer Officer indicated that when trying to commercialise research, licencing is considered the easier model in terms of efforts from the TTO's and academics' perspective. If there is a company that has experience in the area and is willing to take projects forward to the market, the option to licence is considered simpler than establishing a spin out in terms of legal agreements, investments, and recruitment.

The University of Loughborough typically seeks to commercialise a broad range of projects, particularly in the engineering, biomedical and physical sciences areas. This project is instead emerging from the social sciences area, and it presents differences with the usual technologies, typically physical technologies and hard products, because it seeks to commercialise a service model. The TTO reported that the standard process to decide which projects to focus on is based on a set of questions on commercial potential, but that the active engagement from the academic side is crucial. When the researchers are not supportive or not interested in the commercialisation agenda, it is difficult to guide them in the right direction in terms of engaging with licensees and investors. At the same time, when technologies are at a very early stage, there is a lack of clarity in terms of potential benefit for an end user or customer. The project team reported that at the time of making an application to ICURe, the system had already demonstrated a prototype in the intended operational environment.

***'It was mainly an interesting technology and I had a gut feel that could had some value.'***

*Technology transfer Officer*

## **Application to ICURe**

The team participated in the Mid-A cohort delivered by the University of Warwick. Before applying to ICURe with the team, the TTO at Loughborough had considered the option to tender to run ICURe and be a delivery partner. However, they believed the University of Warwick had the right expertise, so they decided to support the programme suggesting to the academics to participate and the TTO helped the team to apply.

The two key elements driving an application to ICURe were, according to the TTO, the possibility or interest in a spin out, and the presence of an Early Career Researcher at the right time in their career and with a commercial interest. In an initial phase, the Principal Investigator experienced difficulties in finding the right student to bring his research forward. However, a few weeks before the application deadline the PI found a PhD student that was looking for opportunities between academia and the commercial world and who seemed the right person to bring his research forward.

***'He seemed a good presence and to be very commercially oriented, I spent two days with him in London and thought 'let's take him on board'.***

*Principal Investigator*

During the application phase, the team reported that each member put efforts into the document and that the TTO provided feedback throughout the process, checking whether the application document suited the requirements of the ICURe programme. The process did not require a lot of resources in terms of time, as the Principal Investigator had several existing documents on the project to include in the application. The PI and TTO reported that this stage contributed to develop the relationship between the members of the team and to clarify their ideas on the project's potential. Given the short time to prepare the application to ICURe, the team did not receive the support of a Business Advisor during this phase.

## Experiences during ICURe

This section describes the activities and experiences of the team during the course of the ICURe programme at each different stage and the key developments as a result.

### Bootcamp

The participation in the Bootcamp, according to the Principal Investigator and the Technology Transfer Officer, has been a helpful preparation for the Early Career Researcher towards the market validation exercise. However, they agreed that the benefits from the Bootcamp often depend on the team's exposure to commercial reality. The TTO reported that he saw the need for more in-depth training on business models, value proposition analysis and networking skills, and that two and a half days were not sufficient for the ECR to gain a deep understanding before the market validation exercise. Despite this, the efforts of the TTO and Business Advisors and the close collaboration with the ECR in this phase helped them to better understand the value proposition.

***'It was valuable, but on the other hand I still believe it would have helped if the ECR had a bit more grounding.'***

*Technology Transfer Officer*

***'The ECR is very smart, is prepared for the business world and academically sound. I think it depends on the person whether the Bootcamp would help.'***

*Principal Investigator*

### Market Validation

Upon starting the market validation exercise, the team explored different market sectors. The Early Career Researcher was keen to explore the possibility to apply the technology to support aid agencies in the developing world, while the TTO and business advisor identified the insurance companies sector as potentially viable. The activities during the market validation exercise were almost exclusively brought forward by the ECR, who identified the key people to talk to and the crucial questions to ask. The ECR conducted more than 200 conversations in seven cities and five countries to assess the technology's market potential. Most of the interviews were conducted overseas, as the main interest for the team was to conduct a global market validation. The Principal Investigator had already been working with several organisations in the UK and had already verified the uniqueness of their technology, but there was the need to understand the potential of the system at the global level.

**Table 1.9: Visits by location during the three-month market validation stage**

	Public (authorities)		Commercial	Humanitarian
USA	NYC	City		
	Washington DC		Mercy corps.	World bank
	Houston	City	ENGI	
	Boulder	City	DigitalGlobe	
Europe	Warwick			Practical action
	Birmingham	City		
	London	City	RMS, Resurgence, AON,	Red cross/Dfid

<b>Africa</b>	Manchester	City	Water companies	
	Netherlands	City	Water board	
	Switzerland	City	Zurich, Swiss RE	Red cross/ UNOSAT/UNHCR
	Kisumu	City		
	Kampala	City		Uganda Red cross
	Lagos, Nigeria	City		
	Tel Aviv, Israel		Waze	
<b>Asia</b>	Macau	City		
	Dhaka, Bangladesh	City		
	Java, Indonesia	City		
	Bangkok, Thailand	City		
	Shanghai, China	City		
	Manila Philippines	City		Asian development bank

### Team support

Throughout the exercise, the project team contributed in the following ways:

**Principal Investigator:** The Principal Investigator was in contact with the Early Career Researcher during the market validation exercise but was not involved in the conversations. In an initial phase, the PI felt he wanted to be more involved in the process, as he had been conducting the research and had intellectual property of the technology. However, he quickly became more comfortable with the idea of the ECR leading the market validation exercise, as he recognised that one of the main objectives was to focus on the ECR's entrepreneurial skills. At the same time, the PI recognised that in the same period he had been busy on the technical side of the project, and it would have been difficult for him to contact the potential customers and the number of people the ECR had conversations with. The ECR made sure to include the PI in all communications during the exercise, and that was a key element found very useful by the PI to remain updated and involved in the project.

**Technology Transfer Officer:** The TTO provided regular support to the Early Career Researcher during the exercise in the form of weekly meetings and regular communication. The TTO supported the ECR in identifying potential market sectors and encouraged to provide summaries of the meetings of the exercise to produce reports.

**Business Advisor:** The Advisor was reported to support the Early Career Researcher working in close collaboration with the TTO. Since joining the team at the Bootcamp, the business advisor attended all weekly meetings with the ECR.

### Options Roundabout

The Technology Transfer Officer indicated that preparing the presentation for the Options Roundabout was a very useful step to clarify the team's ideas and the Early Career Researcher's elevator pitch approach. The delivery of the pitch was led by the ECR and the experience of presenting in front of investors and managers was reported to be an opportunity to practice for the future and for developing his presentation skills. The Principal Investigator also reported that the Options Roundabout and the opportunity to do a practice presentation had been a useful experience, with the members of the ICURe team providing the right support. However, he indicated that more time to improve the presentation would have

been beneficial for the pitch.

*'The ECR did a fantastic job, he is a very good presenter, he got the approach very quickly.'*

*Technology Transfer Officer*

*'We were given feedback in a separate room, I remember that it was useful, but the time was quite limited, we were given an hour to improve the slides.'*

*Principal Investigator*

**Recommendation:** at the Options Roundabout, the project team was advised to spin out and went on to apply for Follow-on funding. The TTO reported that the advice was not clear from the beginning. Initially, the team believed that the outcome of the Options Roundabout consisted in a licencing opportunity, but after further discussions with the ICURe team it was clarified that they could go towards the spin out route and bring the project to the market. The team received well the judgement from the panel and agreed that the confusion could have arisen from unclear messages in their presentation about the route to the market. However, the TTO reported that they received helpful feedback from investors and that they improved their pitch accordingly.

## ICURe Commercialisation Impact

### Business model and application for Follow-on funding

The team was readily made aware of the availability of further funding and secured additional funding from the ICURe programme to support the development of a business plan submission to support their application. The Technology Transfer Officer and the Early Career Researcher were mostly involved in this process and the TTO reported that it was a very valuable stage to clarify the business model. During this phase, the project team also received funding from the University of Loughborough to employ a consultant to write the business plan. According to the Principal Investigator, this has been a crucial step in the team commercialisation plans, as the consultant gradually became more engaged with the project and quickly understood how the team was planning to move forward.

*'The input is about the process to understand what to do and understand the market, the commercial person needs to be really good in terms of communication. I wouldn't imagine that we could find a better person, in terms of the ability to learn what we were doing, and to get our confidence.'*

*Principal Investigator*

This stage helped the team to clarify the business model and to turn the value proposition into an investable business plan. Although the user interface had yet to be clarified, the team agreed to sell the technology as a service model and to engage mainly with insurance companies. The team secured 200k in follow-on funding made available from Innovate UK for projects that follow the spin out route.

### Commercial outcome: Spinning out

The project has since been spun-out as a start-up company, registered in January 2019 and officially established in March 2019. Most of the team members remained involved in the company and have taken up a role in the business. The **Early Career Researcher** is now employed full-time in the company as Chief Operating Officer. The **Principal Investigator** is not fully involved in the company, as he is still 100% employed at the university, but he is a board member and supports the company in developing the technology. The **Technology Transfer Officer** is also a board member while he continues to be fully engaged with Loughborough University supporting other spin out opportunities. and the consultant hired to help with the business plan is the interim CEO.

**Registration of Intellectual Property Rights:** the team had considered to protect the system with a patent, but as the technology is software-based, they protected it with a copyright. Not many issues were reported with this process.

**Progress and challenges:** the team started working on the match funding before the registration of the company. The TTO reported that this phase was a process to prove the spin out itself and make a case for the establishment of a company. One of the challenges reported by the Principal Investigator concerned the phase before the establishment of the spin out. Between the end of the funding to write the business plan and the registration of the company there has been a three-month gap when the Early Career Researcher did not receive a salary, and that has been challenging given the amount of work needed. The team actively engaged with VC and angel investors to assess their interest in funding the company and at the same time applied again for the University's Enterprise Funding that the PI had not secured in 2009 and received 95k as match funding for the company. As reported by the TTO, the current interim CEO has had an important role in the development of networks and contacts with investors, being an angel investor himself and having a background in software development. At the time of the interview, the team was about to sign the first contract in the following weeks. They have some partnership set up mostly in the UK, and several meetings scheduled, including with the Met Office that are considering piloting their system.

***'Revenues will be the critical success factor, proving the value to the end customer. Not many of the customers have used the software so it's going through a pilot phase to get their feedback, those are the crucial elements.'***  
*Technology Transfer Officer*

**Support:** In addition to the TTO, who is still providing guidance to the company, the project team reported to have received support from the ICURe team at the University of Warwick in establishing connections and setting up pitches to investors.

**ICURe contribution:** Although the Principal Investigator was confident that the project would have evolved into a spin out also in the absence of ICURe, but much more slowly and not in such a comprehensive way. A year before the application to ICURe, discussing the commercialisation of the project with the Enterprise Office at the university, the PI had been pushing to establish a spin out, but the process had been slow and there was still a need for confirmation of the commercial potential. The TTO had identified the project's potential, but ICURe was reported to have accelerated this process and to have allowed the potential to be more visible and convincing, both to the university and to investors, and to enable the necessary processes to bring the project to the market. Both the PI and the TTO, when asked how important was participating in ICURe in enabling the team to achieve these results, rated the importance 8 on a scale from 1 to 10.

***'Thinking back, this was a good choice. With ICURe there is an expectation from Innovate UK to the University to get this faster. [...] The first phase was about market validation, and once there was that, the University was then happy and confident that this could become a commercial opportunity.'***

*Principal Investigator*

**Follow-on funding impact:** The PI and the TTO agreed that the availability of Follow-on Funding was particularly beneficial to the team because it allowed to employ the CEO for the company. The Principal Investigator suggested that having a person in the team who is commercially capable is equally important as having a good product to sell and believes that the contribution of the Follow-on Funding has been to give the opportunity to have both the CEO and the Early Career Researcher employed full-time. However, the PI reported that when applying for the Follow-on funding, having a better idea of the amount available for each team would have been helpful to the commercialisation plan. The Follow-on Funding was described by the TTO as beneficial in terms of investments as well, allowing VC funding to be leveraged by public sector funding.

## Wider impact

This section describes the set of wider effects for individuals and institutions that have been reported by the team as a result of the programme.

### Individual outcomes

**Commercial awareness and skills:** The PI and TTO reported that the ICURe programme enabled the Early Career Researcher to improve his commercial skills and take the commercial route. The TTO witnessed a radical change in the ECR's entrepreneurial skills, and the PI felt that the ECR had already strong communication skills and that the programme provided him with the necessary commercial concepts. The main learnings for the Principal Investigator were related to understanding the commercialisation process. Learning how to validate his ideas through ICURe increased his confidence in the feasibility of developing his technology through the company towards a tangible product.

*'During the process I learned IP issues, what is a business plan, and that it made no sense to set up a spin out without a market validation process.'*

*Principal Investigator*

**Career development:** The Early Career Researcher is currently employed full time at the spin out company and according to the TTO, he would remain in the commercialisation area of work even in the case of project failure. The participation in the ICURe programme has given the ECR the opportunity to start an entrepreneurial career. The Principal Investigator, although he did not go through a career change having maintained his role at the University, reported that the programme influenced his research agenda and to be more commercial oriented in his research, thinking of the generation of intellectual property. Moreover, he does not exclude the possibility to become more involved in the company in the future.

*'This could potentially change my career. If the investor company want me to be involved in the company more, I will need to be 80% employed by the company, and 20% by the university.'*

*Principal Investigator*

### Institutional outcomes

**TTO's perspective:** the three spin outs funded through the ICURe programme at Loughborough contributed, according to the TTO, to raise the profile of the Enterprise Office and improve their skills on how to manage the process, increasing the possibility of establishing spin outs from the university.

**Incentives and culture within academia:** A number of initiatives within the University of Loughborough (such as an incubator to support academic spin outs, student start-ups and external entrepreneurs) have contributed to reinvigorate support for commercialisation of research. It was reported that although a change is being perceived in the attitude of academics towards commercialisation of research, research outcomes are still the most important factors leading to promotion.

**Impact on commercialisation of research:** an increase in keenness to encourage spin outs has been indicated as not purely attributable to ICURe, as the University of Loughborough was already becoming enterprise-oriented in the recent years, but it was reported that the programme provided examples of successful companies as a motivation for academics to exploit their ideas about entrepreneurship. In addition, one of the main benefits of ICURe on commercialisation has been indicated to be allowing a significant amount of time to focus on a specific project that could have commercial potential.

*'We've gone from a situation where nobody had previous experience, but the organisation now has 3 spin outs, developing a policy around that, that's a fantastic test case in that respect.'*

*Principal Investigator*

## Case study 6: Investigating the market potential for a virtual reality therapy intervention

### Summary

The project, emerging from the Institute of Neuroscience at the University of Newcastle, looked to develop a unique 360-degree immersive virtual reality system, the Blue Room, providing a therapy-based intervention for children and adults with autism spectrum disorder. The team participated in the cohort 13 delivered by SETSquared and was composed by a Principal Investigator (PI), an Early Career Researcher (ECR), a Technology Transfer Officer (TTO) and a business advisor. Please note that this case study is based on interviews conducted with the ECR and the business advisor only.

During the Options Roundabout, the team was advised to pursue the commercialisation of the project forward through licencing, seeking further public funding, or a private spin out. The team raised further funding in the months following the end of the ICURe programme. However, they were not aware of the Follow-on funding while completing ICURe, but only after months. At the time of interview, the team was in the process of establishing a spin out independent from the University of Newcastle. The process of commercialisation was mainly taken forward by the ECR, with support from the TTO and Business Advisor. ICURe was reported to have helped the project team gain the commercial awareness to start bringing the project to the market, especially through the market validation exercise, giving the team and investors the opportunity and time to understand the technology's commercial potential.

### Background

#### Technology

The project is based on a system that uses immersive virtual reality to deliver cognitive behaviour therapy to treat anxiety in children and adults with autism. The technology consists of a 4-meter x 6-meter space known as the Blue Room where patients sit alongside therapists and interact with environments that would provoke anxiety in real life. During a four-session intervention delivered in one week, the patient is helped to manage anxiety in feared situations, such as public spaces, dogs, birds. The room is composed by screens where the feared scenarios are projected without the need for headsets or goggles, and has a camera connected to a screen in another room to monitor the patient's reactions. The system has enabled children and adults with autism spectrum disorder to participate in activities that were not possible before.

#### Vision on commercialisation

The Early Career Researcher was the main researcher on the project. Before applying to ICURe, four research papers were published on the project and the ECR had identified opportunities for the immersive technology to be brought to the market but had not made any previous attempts to commercialise the research. However, the team reported that prior to the application to ICURe, contact with some potential customers and partners had already been made. Before applying to ICURe, the Principal Investigator had no prior experience in establishing a new business, a spin-out or raising equity finance. The team's Business Advisor had no previous experience in the specific field but had mentored teams to bring companies to the market for several years before participating in ICURe. They had already been involved in the creation of companies, sought public and private funding, and held positions on the management board of companies. They saw the Blue Room project as a unique product that had potential to be commercialised. The project team reported that at the point of submitting an application to ICURe, the system was already proven in its final form in its intended operational environment.

## Application to ICURe

The team participated in the 13th cohort delivered by SETSquared. The team had a standard structure, composed by a Principal Investigator, an Early Career Researcher, a Business Advisor and a Technology Transfer Officer. It was reported that they became aware of the opportunity to apply for ICURe through a recommendation of the Technology Transfer Officer (known as Business Development Manager at Newcastle). The ECR and business advisor have indicated that the key motivation for applying to ICURe was to take the project to the next stage, having already understood its commercial potential and aiming to take it to the market. The Business Advisor reported that a critical aspect was to confirm if the innovation was unique or to find out whether there was competition around the world, and if so what the standards to achieve were.

Overall, the application process was not excessively time consuming for the team, and the Technology Transfer Office provided help with the application, introducing the team members to previous participants to get an overview of the programme and process. However, a difficulty that was mentioned concerned dates and timelines. It took a long time to release the key dates, and they were often changed at the last minute which caused timing struggles when participants had caring responsibilities.

Out of the 27 projects that had applied for Cohort 13, 14 were selected, and this project was ranked 11th.

## Experiences during ICURe

This section describes the activities and experiences of the team during the course of the ICURe programme at each different stage and the key developments as a result.

### Four-day residential Bootcamp

The Early Career Researcher and the Business Advisor described the participation in the Bootcamp as a very positive and informative step. The ECR found the experience particularly insightful and useful to:

- Clarify the value statement and fine-tune the project aims
- Gain confidence in bringing the project forward
- Collect helpful information through pre-reading and presentations
- Develop skills and networks

In terms of support by the ICURe team, the delivery staff and trainers were described as very knowledgeable, supportive and collaborative. The Business Advisor indicated that the Bootcamp was not an occasion where they learned a lot as a mentor but had the opportunity to help his team with training.

## Market Validation

As the team was trying to commercialise an intervention for patients, the market validation exercise was focused on a variety of different contacts and events: doctors, clinics and autism specialists; charities; technical conferences on virtual reality; private healthcare providers; residential settings; and prisons. The Early Career Researcher held meetings with 100 potential customers and attended conferences across the UK and abroad (United States, Dubai, Hong Kong). The following categories were identified as customer segments:

- NHS clinicians, paediatricians, psychiatrists, clinical psychologists



- NHS Trusts, GPs commissioners who can purchase directly
- People who will pay for treatment privately - autism
- Autistic adults, Parents of children with ASD
- Private health providers UK - USA, UK, Middle East
- Health insurance companies
- Private health providers internationally

The majority of the conversations and meetings were scheduled with professors and specialists rather than investors. However, the ECR was surprised by the level of interest in the product globally and by the willingness to invest by private healthcare providers. The Bootcamp was indicated to be a fundamental step for the market validation exercise, enabling the team to reinforce the idea that the project was going in the right direction and that there was commercial potential. However, the ECR did not describe the Business Model Canvas as a useful exercise as it became a task that was not contributing to clarifying the value statement.

## Team support

The Early Career Researcher travelled in the UK and abroad (San Francisco, Hong Kong and Dubai were mentioned) and was alone during this process of market validation but stayed in regular contact with the Business Advisor, updated the Principal Investigator and the Technology Transfer Office with weekly reports, and was supported by the ICURe team through conference calls every fortnight. The ECR also reported to have had a personal mentor throughout the process.

## Options Roundabout

At the Options Roundabout, the main advice given was to move fast with the project and bring it to the market, through a licence, a private spin out or seeking further public funding. The presentation for the Options Roundabout was prepared by the Early Career Researcher in collaboration with the Technology Transfer Officer. The team established a relationship with a company through a member of the panel present on the day, and they have maintained contact. Overall, this stage helped the team realise that the project could be turned into a business and that they needed to move forward with the commercial opportunity.

## Suggested Improvements

The Business Advisor suggested that after the Options Roundabout, the ECR should have received more follow up support in terms of training on entrepreneurial skills or investment meetings to allow the project to progress. They indicated that for example, to ensure the project progresses, the ECRs should be given the opportunity to have a follow up meeting one month after the Options Roundabout to assess progress on commercialisation, instead of simply terminating the programme after this activity. It should also be added that the team reported not to have been aware of the availability of Follow-on Funding after the Options Roundabout and was therefore disappointed that no indications were given after the panel. It was also suggested that the period of market validation should be made longer, extending it by around 4 weeks to allow for travel and opportunities to explore the market potential of the innovation.

## ICURe Commercialisation Impact

### Commercialisation plans

After the Options Roundabout, the team sought to commercialise the innovation through a spin out. At the time of interview, the **Early Career Researcher** and the **Business Advisor** were actively looking for further funding and were starting the process of establishing a spin out company. The ECR was also receiving support from the **Technology Transfer Officer**, who is involving more people within the university to help with documents and funding applications. The ECR reported that one of

the elements that helped the progression of the project was that it had been considered a good commercialisation opportunity from the University of Newcastle.

**Registration of Intellectual Property Rights:** The team has the copyright on the manual and the training programme for the virtual reality therapy as the company will be based on the research done on the treatment. The process did not pose any challenges except for being time consuming.

**Progress and challenges:** after writing a business plan, the team contacted virtual reality providers and are currently having ongoing negotiations. They are also sourcing a CEO for the spin out through the university that has a process in place to support the creation of companies. The ideal person for this role, according to the ECR, would be someone who has previously run a healthcare company and taken a product into the healthcare system, which is a skill set that the current members of the team do not have. The commercialisation plan is first to establish a spin out, then to licence the package to run the intervention. The ECR reported that the creation of the company is expected within 2019 and that the goal will be to generate revenues within the next 12 months. The team secured £50,000 from Health Economics funding and is currently applying for the Follow-on Funding, of which they were made aware only at a later stage.

The process could have been quicker, according to the team, with the right advice on follow-on funding after the Options Roundabout and the necessary support. The Early Career Researcher suggested that in this way there could have been the possibility to spin out even three months after the Options Roundabout. In addition to this, both the ECR and the Business Advisor reported challenges with fundraising and the university's slow bureaucracy, which were preventing the project moving forward. The Business Advisor also described the technology as having a lot of potential but whilst raising interest, struggled to receive grants or licencing deals, so resorted to self-financing instead. They suggested that creating a spin out company as a first step might help overcome these difficulties.

**ICURe contribution:** Although the project is not yet at the stage of commercialisation, the Early Career Researcher is confident that the business will go forward and reported that ICURe contributed to confirming its potential success. The phases of grant application and market validation is thought to show to investors that there is commitment to the project and to its commercialisation. At the same time, spending three months travelling to validate the proposition allows the team to focus on the potential of the project. Both the PI and the business advisor, when asked how important was participating in ICURe in enabling the team to achieve these results, rated the importance 10 on a scale from 1 to 10.

## Wider impact

This section describes the set of wider effects for individuals and institutions that have been reported by the team as a result of the programme.

### Individual outcomes

**Commercial awareness and skills:** The Early Career Researcher reported that the delivery of the project has led to a much stronger commercial awareness from their point of view. They learned how to focus research projects that could have an impact on what is needed and where the research could fit into the marketplace. The Business Advisor also described the ECR's commercial skills as massively improved during the programme.

**Career development and networks:** After completing the programme, the ECR completely changed career, becoming a Business Development Manager at Newcastle University. They will still carry out research in the same area and will remain the academic member of the spin out company. In addition, they decided to be a mentor for ICURe applicants, as they reported that their experience with a mentor had been helpful in the completion of the programme and encouraged them to mentor future participants. In terms of networks and collaboration, the ECR and business advisor reported that

the contacts made during the market validation were particularly helpful for the commercialisation of the research, and that relationships with them have been maintained.

### Institutional outcomes

**Impact on commercialisation of research:** The ECR felt that the environment at Newcastle is different from the rest of the universities in North East England, as the creation of spin out company was a high priority. Furthermore, participation in ICURe has impacted commercialisation of research in terms of encouraging researchers to think about the impact of their findings, which commercial route to take, or in the case of the medical school, whether it could benefit patients.

**Incentives and culture within academia:** An increase in commercial awareness has been indicated by the ECR as attributable to ICURe, making academics aware that their research needs to be focused on potential outcomes and that they need to assess whether there could be a market for their innovation.

## Case study 7: The Translation of Porous Polymer Scaffolds for 3D Cell & Tissue Research

### Summary

Emerging from the University of Sheffield, the project participated in the first North by North West cohort (NxNW-A) delivered by the Queens University Belfast back in 2018 (Q3). The project team have developed a range of porous ceramic and polymer materials for use as scaffolds to support the laboratory culture of human or animal cells in 3D, understood to be more representative of the 3D environment that cells experience in the body than the 2D cells currently in use.

The team applied with a clear ambition to create a spinout during or after their participation in the ICURe programme. At the time of writing, however, the project was not commercialised, and the team had little expectation to be able to commercialise it in the next few years. Though the market validation exercise revealed a keen interest from the market for the technology and its potential applications in various market segments, demand (and thus investment) was deemed to be lacking due to a weak or non-existent regulatory framework. For this reason, the panel at the Options Roundabout advised to pursue sponsored research. And while the PI still has ambition to commercialise, the project has been put on hold until regulatory frameworks firm up and the market is deemed to be ripe. The technology had already been patented prior to the team's application to ICURe. Opportunities for future commercialisation are being looked after by the PI at Sheffield, though the frequency or intensity with which they enquire of such opportunities is unclear to the evaluator. The business advisor and ECR stopped any involvement in the project and pursued other career paths.

Please note that while the project team was composed of the ECR, the PI, the TTO and the business advisor, this case study is based on interviews conducted with the PI and the business advisor only. Whenever possible, feedback from the ECR and the TTO were extracted from their responses to the survey.

### Project background and context

#### Technology description

The culture of human or animal cells for laboratory research traditionally uses cell culture flasks, petri dishes and multiwell plates. These provide only simple flat surfaces for the cells to adhere onto and grow as a monolayer. It is increasingly understood that this "2D" cell culture is not representative of the 3D environment that cells experience in the body, with effects on their health, behaviour, and functions. 2D culture is therefore non-physiological, and also limits the number of cells that can be grown in a given volume. Attention has therefore started to move towards 3D culture environments, where the majority have been developed by individual laboratories with almost no standardised reference materials available.

The project team associated with this proposal have developed a range of porous ceramic and polymer materials for use as scaffolds to support the laboratory culture of human or animal cells in 3D. Uniquely, all of these scaffolds may be produced in various geometries and with varied physical/mechanical properties to support different cell culture applications.

#### Initial R&D activity and vision for commercialisation

These novel scaffolds are produced from two different polymer materials, polycaprolactone-methacrylate (PCL-M) and poly(glycerol sebacate)-methacrylate (PGS-M), both developed in the laboratory of Claeysens and Pashneh-Tala, where the PI worked as a researcher. Research support was also provided by post-docs and PhD students, and the ECR was working there as a PhD student and PDRA. IP rights had been generated prior to the team's ICURe application, and are detained by Claeysens' lab. At the application stage, the technology was deemed to be at the TRL 4.

Prior to ICURe, the bio ceramic scaffolds had successfully been made available as research tools through a University of Sheffield service model (CellSupports). But the team perceived their product as a platform technology, and believed it could be the basis to a variety of applications in a range of market segments. Indeed, 3D cell culture is an emergent market in the pharmaceutical and biotechnology fields, driven by increased research in cancer, stem cell therapies, tissue engineering and regenerative medicine, and adoption of alternatives to animal testing.

However, the technology was considered fairly recent and as such, no prior attempt had been made to commercialise it. ICURe was understood as a first opportunity to investigate their technology's market potential. Yet, since the application stage, the team had a clear ambition to commercialise their innovation. Their medium-term goal was to add the polymer scaffolds to the existing scaffold product lines offered by University of Sheffield service model (CellSupports), providing a wider range of materials for different laboratory investigations throughout the world. They then intended to use this extended list of products as a basis to spin out a new company from the university to commercialise the intellectual property (IP) in laboratory research substrates for 3D cell culture.

***“The technology was so new and recent that we did not have an opportunity to commercialise it. ICURe was the first opportunity and the timing was perfect.”***

*Principal Investigator*

## **Application to ICURe**

Whereas survey results indicate that the PI and ECR heard about the ICURe opportunity through their university's TTO, the interview with the PI revealed that word of mouth and academic networks played an important role as well. Specifically, the project benefitted of word of mouth through the PI's network of former PhD students, one of whom had become a 'patent expert' in the university's TTO. Aware of the existence of the ICURe programme, he recommended the PI to apply for it, and leveraged his knowledge of academic staff at the University of Sheffield to contact and introduce the PI to the relevant persons within the university. Note that it is however unclear whether this person had himself been previously involved in the ICURe programme in any capacity.

**The ECR and the PI were the drivers behind the team's application to ICURe.** At the time, the ECR was part of a larger group of academic researchers and post-docs supporting the PI in the development of the technology in a laboratory environment at the University of Sheffield. As mentioned before, the PI and larger research group at the time felt that this technology was ready for further market exploration, and there was an interest in undertaking a market validation exercise prior to applying to ICURe. Particularly, the team had identified several target markets that could benefit from their technology applications, but was keen to scope the demand, investigate specific market needs, and identify the best strategy and route for commercialisation. They were however unsure about how to go about this, and **ICURe was perceived as a timely opportunity to undertake this market validation exercise within a structured framework** (i.e. trainings, support for Business Plan development etc), and the availability of follow on funding. It is worth noting that the team did not go through any pre-selection process within the university.

The ECR volunteered to take up his role within the ICURe team, as he had been closely working with the PI to develop the underlying technology. The PI and ECR were both involved in the writing of the application, although the PI admitted that **the ECR did the bulk of the drafting and was the application lead**. The ECR however received significant support from the TTO and the PI to refine the application. The PI noted that their team could be understood as 'multi-disciplinary' in the sense that each member detained specific skills and expertise for this application.

The PI and ECR both had some experience of commercialisation processes prior their participation in ICURe. the PI indicated some 24-year experience in licensing innovative technology or research, and about 5 years establishing a new business or spinout. The ECR possessed more limited experience, with 1 year of experience gained in the commercial environment. The TTO had no experience establishing spinouts, but gathered around 2 years of experience supporting others in doing so,

including in raising equity finance. He also possessed around 4-year experience in the commercial environment, and about 2 years licencing innovative technology or research.

Following an initial struggle to secure the involvement of a business advisor on their own, the team received support in this regard from ICURe's delivery partner – **Queens University Belfast**. The PI reviewed this **support as critical to securing the commitment of a business advisor** and valued the fact that the business advisor was external to the team and the university as 'a fresh perspective'. Although this did also translate into an increased need and opportunity cost initially in bringing the business advisor up-to-speed with the project's technical background and commercial potential, the PI believed that 'on balance the benefits outweighed the costs'.

The business advisor had years of experience setting up or turning around companies for himself and others. He had also previously worked with the University of Manchester to commercialise some of their research projects. He had experience in this domain and in engaging with academics in doing so, and mentioned to genuinely enjoy this. He however did not have experience in medical research. He received some financial incentive to participate from the Queen's University Belfast- this ranged between £200-250 a day for 2.5 days at the Bootcamp.

The upfront difficulty in securing a business advisor meant that the application received little supervision from a commercial perspective. Since the application stage, the team had a clear ambition to commercialise their innovation through the creation of a spinout company. Yet the business advisor noted a lack of clear vision on how to commercialise and spin out. And there was a **consensus amongst the team members interviewed that the application would have benefitted from earlier intervention and input from the business advisor**, as none of the other team members had a strong commercial background. The business advisor stepped in one week ahead of the submission deadline, and was able to provide some high-level feedback on the commercial side of things. Though the business advisor believed their application to be 'strong', he noted that it could have been strengthened in terms of costing and market sizing. This could be explicative of the team's application scores, as their overall score was noticeably lower than most of the other applying teams- out of 30 applicants, their application obtained the 22<sup>nd</sup> highest score. This poor performance with the online application seems to have been balanced out with the telephone interview they undertook afterwards, which boosted their overall application score.

Overall, the **application process was not deemed to be resource intensive**, especially in light of the team members' previous experience of other public grants applications. The **costs associated with the application were identified to be people's time, especially for the ECR, PI and TTO**, though they were not able to provide specific costing. It was raised that the current online application system was harder to navigate as a 'multi-disciplinary team', or a team whereby knowledge and expertise is fragmented amongst the different team members. Under the current system design, one person must be designated as the application lead, which makes it difficult for other team members to input on specific sections linked with their expertise (i.e. TTO's expertise on patents and Intellectual Property Rights processes) without relying on the application lead and requiring an added degree of cooperation (and time).

The PI believed that the application process had two key benefits for the team:

- **Grasping the attention of the TTO:** Under the current structure of the University and Tech Transfer Office, it was believed that the TTO would have been aware of the project regardless of their application to the ICURe programme. The PI however believed that their application to ICURe, and their subsequent success, has been critical in crystallising the TTO's limited time and capacity around the needs of their project.

*"He [TTO] would have known anyway for the way the university is structured, it would always go passed him, especially as the university now has a lot of activity around patent and translation. But certainly, it would not have got his attention, that is something ICURe has allowed."*

*Principal Investigator*

- **Prompted the team to engage upfront into a more advanced thinking on the market applications of their technology:** While they initially planned to delay some of this thinking until their participation in ICURe, the

requirements of the application ‘forced them’ to address these important translational elements, and address them in detail upfront. The business advisor however noted that the team’s thinking was still not advanced enough at the time of the application. While he believed this was normal given the limited commercial expertise of other team members, he thought it illustrates the need for an earlier involvement from the business advisor in the ICURe application process. As we will note again below, the business advisor believes this had implications for the rest of the team’s approach to and journey through ICURe.

## Experiences during ICURe

This subsection provides an overview of the Bootcamp, market validation and options roundabout activities, completed as part of the programme.

### Bootcamp

Survey results revealed that the ECR, PI and TTO all found the Bootcamp very effective in preparing the team for the ICURe programme. However, interviews with the PI and business advisor emphasised a **divide on the feedback provided on the Bootcamp**. From an academic perspective, the PI was very positive about his experience of the Bootcamp. He reported that it was **critical for the team to grasp the requirements, milestone and objectives of ICURe**, and the journey they were about to onboard. Though there was no distinct activity that was designed to get across the mission of ICURe, **peer-networking** and engaging with other teams was sufficient to gather this knowledge, and this was an aspect of the Bootcamp very much valued by the PI. He was however unable to recollect specific activities that took place at the time which he supposed was because ICURe puts much emphasis on the ECR. On the other hand, the business advisor was slightly more critical of the Bootcamp, which was still perceived as **‘too basic’ in its commercial training aspect**. It was agreed that the Bootcamp was well-designed to prepare the ECRs to engage in the market validation exercise (especially the ‘pitch’ exercise), though they were not necessarily taught well how to adapt to and refine their argument based on their audience. It was reported for instance that in the early stages of the market validation exercise, the ECR did not necessarily have the correct terminology for his audience. The business advisor also deplored that **not enough emphasis was put on commercial delivery that would be helpful at the end or post-ICURe**. He highlighted for instance that there was insufficient training around the making of a business plan, the information necessary for this and where/ who to get them from.

*“I found that ICURe was not anywhere near as commercial as it needed to be. (...) We teach the post-docs very well how to pitch but not very well how to put together a really comprehensive business plan. A bit more commercial delivery should be added to improve the programme, what we want to know is if we are going to make money or not.”*

*Business Advisor*

### Business Model Canvas / Action Plan

It is to be noted that the BMC and the AP were not distinct, and were talked about interchangeably by interviewees. The BMC and AP were not mentioned by the business advisor, but as per above, he thought the process was not commercially oriented enough. Even though there was in his opinion a consensus amongst the team about what they wanted to do, the PI found the BMC and AP very useful to go into more details in identifying their different target markets.

### Market Validation Exercise

Overall, the market validation exercise was perceived extremely positively by all interviewed, and it was **identified as the activity of the ICURe programme providing the most added value for the projects involved**. The business advisor however noted that 3 months was a short engagement timeframe, and the exercise would benefit from being extended. A period of 6 months (as opposed to the current 3 months) was proposed as a satisfying alternative.

The market validation exercise was led by the ECR, with ‘mentor-like’ support received from the PI, TTO and business advisor. Activities undertaken during the market validation exercise included contacting and meeting key individuals, and attending conferences, events like road shows in an attempt to get access to a variety of stakeholders ranging from customers, opinion formers, suppliers, investors and competitors. The key activities that the team proposed to undertake and listed in their action plan are summarised in Table 1.1.

**Table 1.1: List of proposed activities- Action Plan**

Type of activities	List of activities, potential customers, locations and timings
Customer Visits	USA East coast engagement (ThermoFisher, Beckton Dickinson, Aptus bioreactors) ~ Sep 16-20
	USA West coast engagement (AmGen, Beckman coulter, Millipore Sigma) ~ Oct 1-5
	European engagement (CellGenix GmbH, Dow Corning) ~ Sep 16-20
	UK engagement (Perkin Elmer, Kirkstall) ~ Aug 19-24
	Canada engagement (Montreal Biotech inc., InSymbiosis, BioAuxilium, McGill, Medimabs, Prometic, AngioChem) ~Aug 12-17 (while at IBS)
	Korea engagement (BMS Pharma, Life Technologies, Celltrion) ~Aug 28-30 (while at CPhI, BioPh, ICSE)
	Boston engagement (Sanofi, Pfizer, Merck, NovoBiotic, Merrimack) ~Sep 4-7 (while at Boston BioTech week)
	Germany engagement (Bayer, Pfizer, Sanofi) ~Sep 9-12 (while at EACR)
	Philadelphia engagement (Spark BioTech, Immunome) ~Sep 24-26 (while at The Medtech conference)
	Madrid engagement (Algenex, Helix BioS) ~Oct 9-11 (while at CPhI worldwide)
Trade Shows and Events	International Biotechnology Symposium and Exhibition (Montreal, Canada) - Aug 12-17
	CPhI, BioPh, ICSE (Seoul, Korea) - Aug 28-30
	Boston BioTech week (Boston, USA) - Sep 4-7
	EACR conference "Goodbye flat biology" (Berlin, Germany) - Sep 9-12
	The Medtech Conference (Philadelphia, USA) - Sep 24-26
	CPhI Worldwide (Madrid Spain) - Oct 9-11

All interviewees however deplored an imbalance in the type of stakeholders engaged as part of the market validation exercise, with a tendency to focus on customers at the risk of not engaging sufficiently with the business world, and specifically with investors. This is substantiated with survey data, which reveals that the ECR and wider team engaged



between 60 and 70 customers throughout the market validation exercise, compared a mere 3 to 6 investors. Note that the team also engaged with between 4 to 8 suppliers, and 3 to 15 competitors.<sup>6</sup>

The business advisor was particularly vocal about this aspect of the market validation exercise during his interview, highlighting that a strong engagement with potential investors had been substantially lacking. At times, he thought the ECR fell back a natural instinct for 'academics to talk to academics about technical details'. This could have been because Academia and universities were identified as one of the 5 key markets in their Business Model Canvas, and as the technology had already been trialled out at the University of Sheffield, he might have felt more aware of this market segment, its needs and potential applications, and as such, in a better position to address enquiries. Though we were unable to secure an in-depth interview with the team's ECR to confirm it.

The individual capabilities of the ECR to engage with investors were not put into question, as he was thought of as possessing relatively acute business acumen. Rather, disappointment and frustration from the business advisor emerged as he considered his role could have been to recalibrate the ECR's approach to the market validation exercise. Yet he indicated that **little time was accounted for the business advisor to be embedded in the market validation exercise alongside the ECR, and his involvement was limited to high-level advisory and guidance** throughout the market validation exercise.

***"We certainly did not talk to investors. We met potential customers, potential partners and competitors, and we went to exhibitions to talk to anyone else that could be interested in finding out any more and tried to pick up names from businesses. In the end, there was not enough information that was needed to put together a tangible business plan."***

*Business Advisor*

When prompted about it, interviewees refused to extrapolate the effects it might have had on the commercialisation outcomes achieved (or lack of thereof). The business advisor agreed that it could have had some degree of influence on the quality of the business plan that could have potentially come out had they decided to go forward with spinning out; but it was raised that other factors, including weak regulatory frameworks and market readiness in certain segments (see below) had been more substantially conducive to the non-commercialisation outcomes observed.

Indeed, there was a consensus amongst the team members interviewed that the market validation **was critical in influencing development of project and the direction of the commercialisation**. Interactions with industry helped the team to further refine their knowledge of market needs, and potential applications of their technology in each market segment to meet those needs. It was reported that the exercise helped them to identify markets with the highest value potential.

***"We established that some markets were better than others."***

*Principal Investigator*

The disruptive potential of the product- sensed by the team since the application stage- was indeed recognised by the industry, and the ECR received keen interest from the market regarding potential applications and future development. But with feedback gathered through their interactions with the industry, the team realised through the market validation exercise that their product was much ahead of regulation. Specifically, engagement of potential licensees or investors for the creation of a spinout company were unfruitful, as those approached deplored the lack of clarity around the direction of future regulatory frameworks. This rendered future profits uncertain for investors and business partners, who were eventually not willing to commit equity into the project. Thus, **risks associated with weak or unclear regulatory guidelines have been a key factor hindering progress of the project**.

***"There is no regulatory body in place, there is a long way to having guidelines. It was not commercially viable, there is nothing really anybody could buy and actually use. As it happens with revolutionary technology, the***

<sup>6</sup> There were discrepancies between the survey responses of the ECR and the business advisor. Survey responses of the TTO have been disregarded as they were falling significantly below the amount of contacts reported by both the ECR and business advisor.

***world is just not ready for it yet. (...) everybody was saying the same thing: “well, it’s brilliant but we need to wait 5 or 10 years at least”. We got to the point where everybody was very interested and at the same time not interested at all in it commercially.”***

*Business Advisor*

### Options Roundabout

The entire team attended the Options Roundabout for half a day. For the occasion, the ECR and the TTO had prepared a PowerPoint presentation highlighting the insights gathered through their ICURe journey. However, the team had already concluded with their experience of the market validation exercise that their product was not commercially viable yet, as regulation guidelines were weak or non-existent and the market was not deemed to be ripe. As such, expectations for the Options Roundabout panel were already set, and the team had no specific intention to pitch for commercialisation or investment.

***“The TTO agreed, and we went to the Options Roundabout knowing that we were not trying to pitch anything. We prepared a review for them, but we thought that it was not investable.”***

*Business Advisor*

Feedback they received from the Options Roundabout panel was in line with their expectation and comforted them in the idea that their product had real potential but could not be commercialised in the short term. The project was advised to pursue further (if possible sponsored) research and development until the market was deemed to be ready. Yet there was some disappointment with the quality of the advice from the OR panel, who was **unable to provide clear, actionable steps to progress the project**. Once agreed that the project had no short-term potential for commercialisation, conversations developed to identify the best strategy going forward to keep momentum around the project. The panel suggested engaging discussions with a company developing similar products. This advice was perceived as counterproductive by the PI, who identified them as potential competitors, and thought they would have more incentives to stall the project rather than progress it further.

***“The recommendations from the panel were in fact suggestions to speak to some people. They could not make very good suggestions, it was disappointing.”***

*Business Advisor*

***“I did not think everyone at the Options Roundabout got it. There needs to be a bit of a time lag. they advised us to talk to a company who was our competitor. It seemed a strange advice to me. They have not got a product yet, they had competing material, so naturally they would want to suppress us. I did not think the advice was really good.”***

*Principal Investigator*

It also **clashed with his vision for the future of this project**, as he still holds the ambition to license or spin out in the medium to long term. **Panel attitudes** were also called into question as it reacted with scepticism to the PI’s proposition to publish academic papers to increase the visibility of the technology’s potential, and to keep momentum around the project in the short term.

***“We decided to wait for the market a bit more, and at the same time work on getting papers out, But often in the innovative environment, it makes them nervous as they do not want to be seen as having academic activity. Yet publishing our work would have been an advantage as it would increase our confidence in the target market, raise our profile and strengthen the downstream. We struggled to explain that in this particular context.”***

*Principal Investigator*

## Role of different members throughout the process

All the team members were engaged and motivated. Though the ECR led the project, his survey responses indicate that he was **very satisfied with the support** provided by the other team members. The entire team was reported to be present at the Bootcamp and the Options Roundabout, although the lead and the bulk of the work for both was left to the ECR.

For the market validation, the ECR led the team the exercise with ‘mentor-like’ support from the business advisor and the TTO. The PI was reported to be less present because he was possessing limited commercial experience compared to the other members of the team. However, **proximity** between the PI, ECR and business advisor as they were all based in the same office at the University of Sheffield was reported to have fostered some **informal discussions** which helped to keep everyone up-to-date.

Under the **current design of ICURe**, the **business advisor reported his own involvement to be lacking in structure**. It was proposed that the role of the business advisor be revisited to **increase the intensity of its support** to the ECR throughout the entire market validation exercise, and even so throughout the entire programme. Timing for the involvement of the business advisor was also reported as key, and an **early involvement** before the submission of the application was perceived to be essential. **Sustained support** was also mentioned as necessary to recalibrate the approach and navigate the change of commercialisation direction if necessary. As noted above, it was also suggested that the design and training content of the Bootcamp be revisited with a more practical commercial perspective, including a one-to-one session with the business advisor.

*“Some successful ICURe project that secured funding, you can tell that the way they have done it is that the commercial leads [business advisor] have been with them some considerable time, and not parachuted at the last minute.”*

*Business Advisor*

### ICURe delivery team

Overall, the delivery of the ICURe programme was perceived as **satisfactory**, and the delivery team was reported as **competent**. No other feedback was provided on this topic beyond a general satisfaction.

Support provided by the delivery partner (Queen’s University Belfast) to find a business advisor was praised by the PI. He believed it had been **critical to securing the commitment of a business advisor**, and valued the fact that the business advisor was external to the team and the university as ‘a fresh perspective’.

## Suggested Improvements

The below table provides a summary of suggested improvements for the programme which are discussed in the report body.

Programme design	Finding	Recommendation
Business advisor recruitment	Support by the delivery partner (QUB) to find a business advisor for the was reported as critical by the team to secure a business advisor.	Generalise support to teams from delivery partners at the application stage to secure a business advisor.
Application platform (online system)	The current online application system is harder to navigate as a ‘multi-disciplinary team’, as one person must be designated the application lead, which makes it difficult for other team members to input on specific sections linked with their	Open up the online application platform for the whole team to be able to input, and to foster multi-disciplinary input coordination.

	expertise (i.e. TTO's expertise on patents and Intellectual Property Rights processes)	
<b>Bootcamp</b>	Bootcamp content still lacking some practical, commercial training	Include some more practical commercial training, potentially on a one-to-one session with the team's business advisor i.e. adapting pitch to audience, how to gather necessary information in the market validation exercise to build a tangible business plan, and from whom etc
<b>Market validation exercise</b>	3 months was considered a short engagement timeframe, and the exercise would benefit from being extended.	A period of 6 months (as opposed to the current 3 months) was proposed as a satisfying alternative.
<b>Role of the business advisor</b>	Current role of the business advisor is lacking in structure, and intensity is not enough to provide sufficient support to the ECR, especially during the market validation exercise.	Clarify the role of the business advisor, its scope, incentives, and trying to build enough time for: <ol style="list-style-type: none"> <li>1. Early involvement of the business advisor ahead of the application deadline for him to review this application, get to know the project and the team;</li> <li>2. Sustained involvement throughout the programme, especially at the stage of the market validation exercise.</li> </ol>
<b>Options Roundabout</b>	Advice given by the panel at the Options Roundabout were disappointing for the team, and did not provide them with actionable guidance to progress the project.	Develop more structured and actionable guidance about next steps to take forward projects that are not yet near enough commercialisation (not spinning out or licensing).

## ICURe Commercialisation Impact

### Non-commercial outcomes

Advice from the Options Roundabout panel was to **pursue further R&D**. This was in line with the team's expectation and conclusions from the market validation exercise that the project was not commercially viable or investable in the short-term due to high risks linked with high regulatory uncertainty. Project team decided to follow this advice, pursue further R&D, publish academic papers, and wait until future commercialisation opportunities arise. Following the OR, the business advisor and ECR stopped any involvement in the project and pursued other career paths.

The technology went back to the Claeysens lab at the University of Sheffield, though no specific R&D has been engaged at this stage. At the time of interview, the project had terminated ICURe 6 months ago. Holding the IP rights with the university, the PI is involved with the HEI/ TTO in the future development of the project. It is however **unclear to the evaluation at this stage whether the team still has a clear path to commercialisation**, and it seems that **none of the team members now has the role, responsibility, nor the time to dedicate to progress the project**. Timescales for any future commercialisation outcomes were deemed to be uncertain, as the process to track and influence the developments of the future regulatory framework was perceived to be complex and challenging.

*“My take is that it is not investable now, but with further or sponsored research, starting to lobby the authorities and how they determine regulation, this project can be valuable. But that is time consuming, and to the best of my knowledge the post doc went on to media or television.”*

*Business Advisor*

## Wider impact: individual outcomes

### Commercial skills, research agenda and career prospects

His responses to the survey suggest that the **ECR has strong commercial skills** (on all the commercialisation skills suggested, he never scored himself less than a 5 out of 7). Though it is **unclear if his participation in ICURe helped him to enhance those skills**, as he was already perceived by the remaining team members as a very motivated, proactive and commercially-sound person beforehand. We were unable to secure an interview with him to gather his perspective.

It was however hinted by the business advisor that the **ECR's participation in ICURe had positively influenced his career prospects**. Indeed, he enjoyed his experience participating in ICURe, raising an interest in pursuing a career in the private sector. After ICURe, he became a spokesperson for the University of Sheffield and, once his PhD terminated, he left academia to take on a job in the media industry.

For the **PI, participation in ICURe further enhanced his awareness of research commercialisation**, though he admitted it was something he was already interested in before ICURe. Though he did not report having started any subsequent research programme drawing on knowledge acquired through ICURe, he engaged in an initiative with the ECR to raise awareness amongst PhD student and senior researchers within the university around research commercialisation (see institutional outcomes below).

### Networks and collaboration

The PI reported that working in a **multi-disciplinary team**- especially with a business advisor external to the project and with no prior acquaintance with the other members of the team- allowed to bring a **'fresh' perspective** on the product. For the **business advisor, participation in ICURe has broadened his contact within universities' TTOs**. For example, he reported to have stayed in contact with TTOs of different universities met through ICURe, and to exchange now and then about research commercialisation opportunities. But he indicated to now have retired and stopped most commercialisation activities.

## Wider impact: institutional outcomes

### TTO skills and capabilities

The PI reported that **capabilities of the TTO staff were excellent**. It is however unclear whether ICURe contributed in any way to improving the capabilities of TTOs at Sheffield. But effectiveness and efficiency of tech transfer services were hindered by the university's **structure and processes** to identify research with commercial potential and to support the commercialisation, which were qualified as currently **clustered and somewhat incoherent**.

*“We have a group who would do external engagement and civic engagement, and they are fantastic. Then we have the research services department, who have good relations with the external team, but they are not coherent, separate teams with separate bosses. The structure is just a bit weird. I think they take a unique approach to a common problem. We have the central team including technology transfer, they also demand a specialist group at the faculty level.”*

*Principal Investigator*

Structure of the **university's top management** and its ability to set a vision and implement structural changes was perceived as key to impact the structure (and thus quality and coherence) of tech transfer services.

***"We were brilliant for a long time, then we had a bit of a hiatus and the university executive board did not have a big seat at the table. Now I'm very optimistic that the current [management] will do structural changes, but it will take time."***

*Principal Investigator*

Impact on commercialisation of research within their university/ academic culture

ICURe's impact on changing academic culture was perceived as mitigated. After their participation in ICURe, the PI and the ECR worked in different ways to raise the profile of the ICURe programme within their universities. The ERC and the PI became 'spokespersons' at the University of Sheffield and tried to raise awareness of research commercialisation and of the ICURe programme, and gauge interest amongst fellow senior researcher to join in further cohorts. This was thought to have had mitigated results, being somewhat successful in profile raising but disappointing in its abilities to attract senior academics.

***"The correct answer would be 'yes it has had a huge impact' but I don't think it was the case. It raised the profile of commercialisation and of ICURe, so going forward it would attract more interest."***

*Principal Investigator*

Reasons invoked were two-fold:

- Some persisting **resistance in the academic culture**, with some individuals perceiving commercialisation of research as a distraction to their core 'research' job. This was however not thought to be the majority of people. Most academics just reported to be very **busy** and **commercialisation not being their top priority**, they are willing to engage in conversations with the TTO without necessarily committing to commercialise themselves.

***"What I would have wanted to see is attracting interest from more academics. We tried to recruit a lot of senior officers, but they did not express a lot of enthusiasm in joining us. It was something groundbreaking in terms of changing academic culture. It was a good opportunity and it was disappointing we could not bring more of ICURe in the academic world and raising the profile."***

*Principal Investigator*

- A **preference for other forms of public grants, perceived as less invasive** than the ICURe funding by universities and academics. According to the PI, this is stemming from an existing 'power struggle' between the universities and the government. The government would be in favour for full transparency and accountability, whereas universities would prefer to bring public funds in-house and use it for their own research purposes with as little scrutiny as possible, which other public grants of the likes of the MRC would allow more easily.

Yet academic culture was perceived as having evolved considerably and rapidly in the direction of an increased valuation of **research commercialisation**. ICURe was identified as pertaining to this context, though not considered to be the only nor necessarily the main driver of it. The introduction of the new REF framework- putting significant emphasis on impact of research- was also perceived as key to set incentives.

***"Turning research into impact is now recognised by the government as a priority for universities. And universities are catching up with that."***

*Principal Investigator*

## Contribution

### Project level

Given that no commercial outcomes have been pursued, ICURe's contribution at the project-level has been **limited**. Nonetheless, ICURe provided the team with the **opportunity to conduct the market validation exercise**, which the PI and ECR would have done any way with this new technology. However, it was said to have helped to **accelerate this process**, as the PI admitted that on their own, the team might not have gone ahead with the market validation exercise for some months or years. The ICURe programme also provided a structure for this, helped secure the attention of the TTO to investigate fully the market potential of this product. The involvement of a business advisor, external to the project, was also said to contribute a 'fresh perspective'. The PI still has objectives to commercialise in the long run in the form of a license or spinout.

**Individual and institutional outcomes:** see sections above.

## Attribution

### Project level

Important market barriers (i.e. high risks associated with uncertainty around regulation) significantly hindered the commercialisation opportunities of the project, and participation in ICURe was not sufficient to overcome such barriers.

### Institutional Level

The introduction of the new REF framework – putting an extra emphasis on turning universities' research into impact - was perceived as key to set context and incentives for an increased valuation of commercialisation of research amongst universities.

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### **About Ipsos MORI's Social Research Institute**

The Social Research Institute works closely with national governments, local public services and the not-for-profit sector. Its c.200 research staff focus on public service and policy issues. Each has expertise in a particular part of the public sector, ensuring we have a detailed understanding of specific sectors and policy challenges. This, combined with our methods and communications expertise, helps ensure that our research makes a difference for decision makers and communities.