MULTIPLY Global Ltd

B2B Technology Transfer in the UK Space Sector Study, 2020

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About MULTIPLY Global Ltd

Natasha founded MULTIPLY in 2015 with the vision to unleash the potential in technology and people.
MULTIPLY works with advanced engineering companies to multiply value through technology transfer programmes and ventures. Realising over £30m across a portfolio of advanced engineering clients specialising in space, aerospace and defence, automotive, energy, security and transport. Providing low-risk routes to take technology into new markets, new applications, or through new business models. From setting initial strategies to delivering programmes and establishing new ventures.

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Foreword by the Chair: Katherine Courtney

Cochlear implants, portable computers, memory foam mattresses, scratch-proof lenses, the DUSTBUSTER vacuum - all technologies making our everyday lives easier here on Earth. They all found their origins in NASA's Apollo space missions.

Space is a harsh, technically challenging environment where products that fail generally cannot be repaired. Technologies that withstand the rigours of operating in space: the extremes of heat and cold; the violent buffeting of leaving the Earth's atmosphere; the need to minimise weight, volume and power consumption – can offer great advantages when applied to tackling terrestrial problems.

This is reasonably well understood by space agencies, research institutions and major aerospace corporations. Some have technology transfer programmes seeking to identify new applications for space technologies. Nevertheless, many more space sector businesses in the UK have the potential to exploit their innovative technologies into non-space markets - but fail to do so - missing opportunities for revenue generation and growth.

In this study, MULTIPLY Global examines the technology transfer opportunity, explores the barriers (real or perceived) holding companies back, and recommends joint public and private sector action to unlock the potential economic benefits of greater exploitation of space technology in other markets. I would encourage anyone with an interest in the UK's future industrial strategy to read it. To paraphrase Neil Armstrong, the next great technological "giant leap for mankind" may very well already be in development as part of a current or future UK-supplied space mission.

Katherine Courtney

Chair, MULTIPLY Global Ltd, Advisory Board

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Executive Summary

This study was conducted by MULTIPLY Global Ltd (MULTIPLY), a B2B technology transfer service provider, whose work focusses on B2B technology transfer for advanced engineering sectors including space, aerospace, energy, transport, mining and defence and security.

MULTIPLY has initiated and led a number of programmes to maximise the value opportunity in B2B technology transfer to and from the UK space sector, which highlighted a number of assumed benefits:

- **Sustainable growth**
  - Revenue generation
  - New market creation
  - Positive environmental and societal impact
- **Risk reduction**
  - Portfolio of competitive products
  - Portfolio of markets and applications
- **Positive economic impact**
  - Job creation
  - Export growth
  - Attracting inward investment

This prompted the initiation of this study to confirm or disprove the above assumptions and open discussion with industry and government on routes forward to multiply value through B2B technology transfer.

A review of secondary research, informal market interviews and a market survey was conducted to understand the current landscape and potential of B2B technology transfer in the UK space sector, the opportunity and the barriers.

The findings from the research have proven the hypothesis that…

…Investment into B2B technology transfer to and from the UK space sector improves resilience, creates sustainable growth, and has a positive societal and economic impact.

Technology transfer from space appears to exceed £3-4 return on every £1 invested[1], however it is unclear if it could realise nearer £7.30 GVA for every £1 invested by UK government into innovation[2]. In part due to the lack of clarity on whether technology transfer is wrapped in the innovation investment category and whether it refers to B2B, academic to industry transfer or both.

Recognition for B2B technology transfer is low, using terms like 'spillover' indicate accidental or responsive transfer rather than a pro-active effort. This is re-iterated by the survey response showing **over half (52%) of respondents do not do technology transfer and only 18% pro-actively do**. Comparatively, survey responses including engineering

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/774450/LE-SHUKSI_2018-SUMMARY_REPORT-FINAL-Issue4-S2C250119.pdf

[2] https://www.kcl.ac.uk/policy-institute/assets/the-road-to-2.4-per-cent.pdf

companies that do not have space as their primary market, showed 36% actively doing technology transfer. Highlighting that the space sector has an opportunity to benefit from technology transfer activity.

The majority of technology transfer activity and effort comes from academia to industry, an essential driver of technology advantage and innovation. However, academia has experienced a number of challenges doing technology transfer including a lack of business skills, long time to market and variable ROI and fail rates.

B2B technology transfer can address these barriers, supplementing academic activity and addressing the opportunity to advance the space sector commercially – creating a resilient sustainable sector, whilst driving up GVA and associated benefits. The interviews and survey highlighted a desire by most companies to do technology transfer with revenue generation, demonstrating leadership and innovation and bringing additional learnings back into the core business as a key-driver.

Recommendations in this study focus on the long-tail of the space community, SMEs and large companies, who have the technological maturity but lack the bandwidth and skills required to transfer technology.

The recommendations are calls to action, action to develop the right support mechanisms through private and public effort. The recommended approach to do this is to **target** companies with the potential to transfer technology, **de-risk** them to provide confidence and **build capability** through the right support mechanisms including:

- Further Insight and Design – building a customer led programme of support mechanisms.
- Policy Development – collaboration between private facilitators and government to raise awareness and embed into policy.
- Financial Mechanisms – from loans to skills vouchers and grants to support companies transferring technology.

There is the opportunity and the appetite to drive technology transfer to and from the UK space sector. Improving GVA, diversifying portfolios so de-risking businesses from external impacts whilst building a commercially sustainable industry.

MULTIPLY recommends a joint public and private effort to implement the funding and support mechanisms detailed in this study to make this possible.

Technology Transfer

Definition

Technology transfer does not have a globally accepted definition, in its broadest form it is the sharing/transfer of knowledge. More specifically it is seen as the process of transferring technology from the entity that owns it to another entity. When referring to technology transfer in this study it is based on the following coined definition:

> *The transfer of knowledge, processes or technology from one entity into new markets or/and new applications in return for commercial value add (i.e. revenue, market access, brand awareness and positioning)*

Academic and B2B Technology Transfer

There has been significant research and investment by Universities and via government funding vehicles to stimulate and enable academic to industry technology transfer. Focussed on the commercialisation of university owned patents, technology transfer offices will act as conduits for university to industry technology transfer through licensing and new company creations.[3]

University technology transfer (UTT) is key to innovation, growth and competitiveness at an academic, governmental and industrial level. However, despite over a hundred years of technology transfer from academia to industry there are barriers to entry. According to the Lambert's Report (HM Treasury, 2003: 14) "companies and universities are not natural partners". This lack of affinity has resulted in tension and conflict throughout the history and process of UTT (Larsen, 2011)[4].

The key challenges to realising value from technology transfer in this scenario are having the business expertise to build a commercial entity, the long time to market and the variable ROI and fail rates, as detailed in RSM's report *(Figure 1).*

Table 20: Characteristics of university spin-outs in comparison with high-technology[54] start-ups

Rank	Compared to high-tech companies, USOs are more likely to	Mean
1	Require building a management team	4.4
2	Require a longer investment time horizon	4.3
3	Require close monitoring	4.2
4	Require several rounds of funding	4.2
5	Have higher variability of return	3.6
6	Fail	3.6
7	Involve protracted pre-deal negotiations	3.5
8	Be small niche market companies	3.3
9	Pose valuation difficulties	3.2
10	Have financial structuring problems	3.1

Source: Wright et al, 2006;.
Note: respondents ranked each factor as: 1, strongly disagree"; 2, "disagree"; 3, "neither agree nor disagree"; 4, "agree"; 5, "strongly agree".

Figure 1: RSM Report - Characteristics of University Spin-outs vs High-Growth Start-ups

The House of Commons report[5] by the Science and Technology Committee also highlighted some underlying problems of a 'review culture' and an 'implementation deficit'. Government attention on technology transfer is welcomed, however the Royal Academy of Engineering has stated that there are currently 'limited materials' available

[3] https://www.imperial.tech/media/uploads/files/Technology_Transfer_in_The_UK.pdf
[4] https://pureadmin.qub.ac.uk/ws/portalfiles/portal/107763026/Quad_SLR_R_D.pdf
[5] https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/755/755.pdf

that ‘provide comprehensive guidance on approaches to market assessment and opportunity evaluation’ for technology transfer.

The B2B technology transfer landscape has had much less publicity and reporting conducted. This in part is due to the complexity of understanding what technology transfer is and where it sits. Often, we’ll see technology transfer, as defined in this study, captured as part of in-house R&D activity, interchangeably referred to as innovation. As such understanding of the impact of pro-active B2B technology transfer activity generally and more specifically in the UK space sector could be grossly misunderstood. As with any misunderstanding, there is a risk that the value of the opportunity is not being realised through lack of support (which aligns with the Royal Academy of Engineering’s observation of the lack of support and guidance) and resourcing. If we take the findings from the RSM report as an indicator we can assume that B2B environments are more likely to have the skills (the management team) the knowledge (understanding returns) and environment (processes, experience and network) to mitigate the risk of failure, reducing time to market and maximising value return.

Technology Transfer in Context of the UK Innovation and R&D Landscape

> *“Enterprises which implement active strategies of technological development have the greatest significance for the economy.”*[6]

The value of innovation is well recognised, with government and match funded industry investment into innovation realising £7.30 Gross Value Add (GVA) for every £1 invested. With just over 1.6% of GDP in the UK being invested into R&D the ambition is to increase that to 2.4% more closely aligned to other OECD countries[7].

The challenge is to understand how much technology transfer contributes to that value creation today to inform future investment. The UK Innovation Survey of 2019[8] highlights a number of key areas that are indicative of technology transfer activity as part of the UK innovation and R&D landscape.

Over half of innovation expenditure was on internal R&D *(Figure 2)*, where we assume technology transfer activity typically lies. However, as part of this view there is very low investment into the market introduction of innovations which is the key bridge to commercialisation. This indicates long lead times, lack of skills and support or/and a high failure rate of research and development

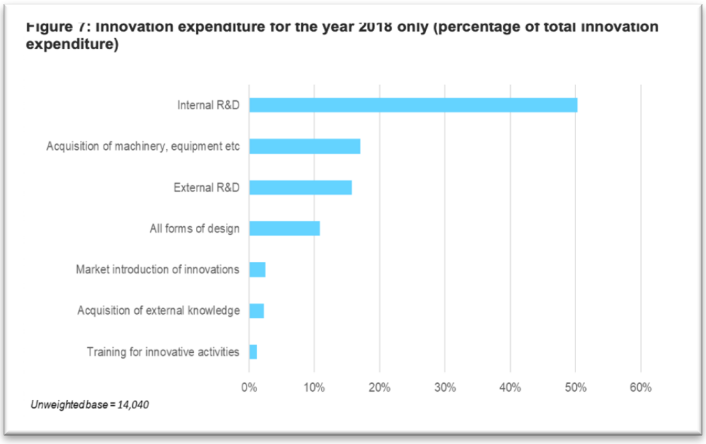

Figure 2: UK Innovation Survey 2019 - Innovation Expenditure 2018

[6] https://link.springer.com/article/10.1007/s00181-019-01683-8
[7] https://www.kcl.ac.uk/policy-institute/assets/the-road-to-2.4-per-cent.pdf
[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873740/UKIS_2019_Headlines_Findings.pdf

activity. This in turn raises the question of what economic impact and commercial confidence and return criteria are being used to assess investment at the R&D stage.

The UK Innovation Survey *(Figure 3)* highlights three factors that are typical of technology transfer activity of transferring to new markets or new applications:

- Increase value added
- Increase range of goods or services
- Entering new market

The report also highlights what the barriers are to innovation, with cost factors dominating. It also indicates that implementation or/and the decision to implement are challenges citing perceived economic risks, lack of information and uncertain demand.

Table 5: Innovation factors (percentage of all broader innovators rating factor as of "high" importance to their decision to innovate) 2016-18

Innovation factors	Size of business		
	SME (10-249 employees)	Large (250+ employees)	All (10+ employees)
Improve quality of goods or services	43	45	43
Replace outdated products or processes	36	35	36
Meet regulatory requirements	32	37	32
Increase value added	32	34	32
Increase range of goods or services	30	29	30
Increase market share	29	31	29
Reducing costs per unit produced or provided	24	29	24
Improve flexibility for producing goods or services	24	25	24
Entering new market	23	18	23
Increase capacity for produced goods or services	23	26	23
Improve health and safety	22	26	22
Reduce environmental impact	20	24	21

Unweighted base = 6,389

Figure 3: UK Innovation Survey 2019 - Innovation Factors

Looking at technology transfer as part of international innovative activity across the EU, a paper published in 2019 by researchers in the Faculty of Economics and Management at the University of Bialystok, Poland, highlight the positive correlation between international technology transfer and innovation in a country. Interestingly those countries ranked high on international technology transfer (Luxembourg, Netherlands) are typically small economies relying on the service sector.

"In the long-term, technology transfer is the main component of technical progress as it leads to increased productivity and helps to narrow the gap between less and more developed countries. As a result, the return rate from innovative investments is more than twice as large as those in physical capital."[9]

[9] https://www.researchgate.net/publication/332133654_International_technology_transfer_and_innovative_changes_adjustment_in_EU

Technology Innovation
Contribution from Dr. Richard Adams, Cranfield University

Reader in Entrepreneurship at the Bettany Centre for Entrepreneurship, Cranfield University, and has previously held positions at Universities of Surrey and Exeter, Imperial College London as well as with the UK Cochrane Centre. Dr Adams's work, which lies at the intersection of (responsible) innovation, digital disruption, sustainability and technology entrepreneurship, is practically focused and seeks to meet the twin hurdles of academic rigour and industrial relevance.

"Innovation, the process of invention and implementation of new ideas, is critically important for a firm's survival and continued prosperity.

When innovation occurs, when new technologies and entrepreneurship meet, exciting things can happen with potentially far-reaching consequences. Historian Lynn White Jr's[10] hypothesis is that the origins of feudalistic governance which so dominated European society in the Middle Ages can be traced back to the introduction of a simple novel technology implementation – the stirrup. The stirrup revolutionized warfare, leading to the emergence of an elite, chivalric, skilled, professional and costly mounted warrior class around whom a sustaining infrastructure of institutions, regulatory frameworks, social structures, economics, commerce and work necessarily developed. Roll forward to more recent history and similar effects are noticeable as consequences of the agricultural, industrial, oil-fired and digital revolutions. **The impacts and rewards of innovation can be significant: accelerating economic development, driving the growth of new industries and equipping humanity with new capabilities.**

The way in which technology innovation and commercialization happens in organisations has changed over time. Roy Rothwell in his widely cited 1994 paper[11] *Towards the fifth-generation innovation process* describes how these processes have evolved and changed over time: from simple linear models to increasingly complex highly interactive models. Rothwell's *fifth-generation* innovation model emphasises knowledge accumulation, of what Bessant[12] calls ***knowledge spaghetti*, through inter- and intra-firm collaboration, systems integration and extensive networking** facilitated by digital networking technologies. Knowledge is a core asset of the innovation process and its management an essential capability.

So, no longer is innovation the preserve of the heroic lone inventor, nor even is it the preserve of white-coated scientists in the R&D lab which was the dominant model of corporate innovation from the 1950s to 1980s. **Contemporary technology innovation and commercialization is much more open (it happens within and beyond**

[10] White, L. (1962). Medieval technology and social change. `Oxford University Press.
[11] Rothwell, R. (1994). Towards the fifth-generation innovation process. International Marketing Review, 11, 7-31.
[12] Bessant, J. (2013). Innovation in the twenty-first century. In: Owen, R., Bessant, J. & Heintz, M. (eds.) Responsible innovation: Managing the responsible emergence of science and innovation in society. John Wiley & Sons.

the boundaries of the organisation), collaborative (is inclusive of and often requires a diversity of knowledge types) and distributed (the requisite knowledge and expertise do not all reside in a single location).

Indeed, in recent decades, a typical innovation feature of large multinational and technology-intensive companies has been the increasing occurrence of **globally distributed innovation teams which exist either to exploit the assets of the parent firm perhaps by opening new markets or adapting products** for local conditions or to acquire or improve assets by exploiting the advantages of the host country; for example by taking the opportunity to access and capture foreign market knowledge and technology expertise.

Contemporary innovation is, then, with its emphasis on (new) knowledge combinations, face-to-face interactions, internal and external collaborations, co-operation, cultural tolerance and conducive climates, a very human activity: all of which makes it a complex process to manage. Whether or not it is a globally distributed innovation process as described above or one that takes place within a regional ecosystem, increasingly, innovation is recognised as a process of orchestration of knowledge resources and relationships. However, orchestration can be challenging and the journey from invention to widespread adoption, or successful commercialisation – that point when a new technology product has penetrated the mainstream customer and user community – can be long, difficult and expensive.

In the commercialization journeys of new technology innovations, researchers have identified three major stumbling blocks: the valley of death[13], the chasm[14], and the saddle[15]. In a major study of in excess of 300 technological innovations across multiple sectors, Phadke and Vyakarnam[16] provide evidence to strongly suggest these road blocks, the so-called ***Triple Chasms,*** **are an empirical regularity – they are common to many journeys, and require specific strategies to cross.**

Chasm I is the first hurdle for all science and technology entrepreneurs and, at this stage, the principal focus is on turning successful research ideas into something viable, the transition from concept to prototype: proving the technology in the context of a meaningful value proposition. **At the point of Chasm II, the principal challenge is for firms to move beyond their lead-user base to engage with a different category of customer who are attracted by the emergent and stabilising value proposition**. At this point, the product is being positioned to meet the needs of a distinctly definable market space and a trajectory for growth becomes visible and viable. Chasm III marks the point at which the main body of customers/users replaces the early adopters and the firm begins to scale significantly through effective marshalling of customer segmentation, distribution, marketing and sales activities."

[13] Frank, C., Sink, C., Mynatt, L., Rogers, R. & Rappazzo, A. (1996). Surviving the "valley of death": A comparative analysis. The Journal of Technology Transfer, 21, 61-69.
[14] Moore, G. A. (1991). Crossing the chasm: marketing and selling high-tech goods to mainstream customers, New York, Harper Business.
[15] Goldenberg, J., Libai, B. & Muller, E. (2002). Riding the saddle: How cross-market communications can create a major slump in sales. Journal of Marketing, 66, 1-16.
[16] Phadke, U. & Vyakarnam, S. (2017). Camels, tigers & unicorns: rethinking science & technology-enabled innovation, World Scientific.

The UK Space Sector

The UK Space industry has seen significant growth and investment into downstream, upstream and capital investment opportunities to secure space access, services and innovation in a bid to grow to 10% of the global market share of the space sector.

Focus has been on telecommunications from commercial satellite services making up approximately 45% of the reported industry figures[17]. Investment into launch capability is a critical infrastructure capability supporting government obligations from a security and defence perspective as well as wider economic development opportunities. The UK has a strong legacy in satellite development with active roles in ESA and NASA programmes.

Most recently the growth in 'new space' has seen a surge in downstream space services and products that leverage space enabled services like GNSS, satellite imagery, atmospheric monitoring. This new growth area is supported by government funding and agents, incubation centres, and an emergence of space focussed venture capitalists like Seraphim and New Space Finance.[18]

The Prosperity from Space report focusses on a global partnership strategy for the UK with the aim of creating an eco-system that contributes £3bn to the economy attracts inward investment in excess of £3bn and realises £5bn in export revenues. There is an appetite for growth, the challenge is where do we invest?[19]

Space in the UK is relatively nascent despite recent growth and the UK's legacy in this sector. As such, it is R&D intensive as an industry. With a heavy reliance on government funding, with government and military being anchor customers in most cases – an agenda which, to date, has been driven by defence and security needs. This will not and should not change as the industry matures, but when we look at new emergent markets that have moved past the R&D phase into a market-focussed commercial phase we see a new commercial model and one which is imminent as the space sector matures. An example of this beingthe digital revolution and uprising of FinTech, HealthTech and InsureTech created a new landscape that has endured, is commercially sustained (generating customer revenues), competitive and attracts private inward investment.

The OECD recognises technology transfer as a propagation mechanism that can trigger innovation, directly benefitting the economy and addressing critical social challenges. It is recognised as being able to reduce costs, enhance productivity, increase portfolios of competitive products and can lead to new emerging market creation[20].

[17] https://www.oecd-ilibrary.org/science-and-technology/the-space-economy-in-figures_602407b1-en

[18] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/774450/LE-SHUKSI_2018-SUMMARY_REPORT-FINAL-Issue4-S2C250119.pdf

[19] https://sa.catapult.org.uk/wp-content/uploads/2018/09/Prosperity-from-Space-strategy_2May2018.pdf

[20] https://www.oecd-ilibrary.org/science-and-technology/the-space-economy-in-figures_602407b1-en

UK Space Sector: Collaboration toward Robotics and Autonomy
Contribution from Sam Adlen, Satellite Applications Catapult

"The next wave of innovation in the space sector is going to be underpinned by robotics and autonomous operations. Through leadership in regulation, the UK has a large proportion of start-ups in the area of in-orbit servicing and debris removal. By building capability in autonomous robotic operations needed for servicing and debris removal, these capabilities can strongly position the UK for future opportunities based around in-orbit construction and assembly.

From fractionated constellations to massive antenna and telescopes to space energy and exploration the need and opportunity for robotics is huge. The UK has strong robotics capability in academia and **adjacent industries and bringing these communities toward the space sector** is a critical element in supporting the UK toward a strong and ambitious future in space."

Technology Transfer in the Space Sector

The research has shown awareness and pro-active effort being made toward technology transfer, however, looking closer, pro-active (dedicated departments or programmes) not accidental technology transfer is reserved for two sub-sectors of the industry:

- Large organisations (250+) or Primes: 29% of space sector: Typically, have dedicated in-house innovation/technology transfer divisions, as they have the funding, influence and resources available to them.
- Government funded agencies: i.e. ESA, NASA, STFC: As with large organisations they have dedicated divisions, possible through funding and resource access[21].

The remaining 71% of small, micro and medium enterprises in the sector are what this study focusses on.The UK space industry is one of a long tail of small companies and with sector growth we can expect to see more new space companies being formed.

Often referred to as 'spillovers', technology transfer from space appear to exceed £3-4 return on every £1 of public expenditure. The lag is typically 3-5years (note this is based on ESA programmes, not cross-industry view) and supporting programmes and investment are often required to support the commercialisation of the outputs of space R&D. The dominant factors on technology transfer impact comes down to the diversity of the technologies, the degree

[21] https://www.parliament.uk/documents/commons-committees/Exiting-the-European-Union/17-19/Sectoral%20Analyses/34-Space-Report.pdf

of maturity, specificity/generic nature of the technology along with the relationship between innovator and recipient and the internal structure of both parties[22].

The 'Spillovers in the Space Sector' report by London Economics highlights that without government support, private companies are likely to under-invest in activities with positive spillovers because they cannot fully capture all the benefits of these activities. Despite this, the spillover rate of return typically is 2 to 3 times larger than the private return of an investment. Technology transfer can drive a multiplier effect, but often the ripple effect will have far-reaching societal as well as economic impacts, strong government support increases spillovers if implemented effectively.

Key determinants for 'spillover' activity from an internal perspective (funding and technological) reported by London Economics include:

- Technological maturity and reliability
- Investment channel (noting that research councils generate the most spillovers)
- Likelihood of commercial success (managing risk)
- Product innovation over process innovation

An example from NASA of pro-active technology transfer highlights the significant value opportunity that can be realised.

"Since 1958 NASA has invested approximately $3.7 billion in life sciences R&D in the support of the successful human space flight program... This study [measures] only economic impacts to the companies that developed successful spin-off products from NASA life sciences investments. A personal interview was conducted with each company and the benefits are conservatively estimated as the value-added by the NASA technology to the company's output and the amount of additional private R&D stimulated by the NASA R&D. This pilot study of fifteen companies, using a very conservative measurement technique, found a large return to companies that have successfully commercialized NASA life sciences spin-off products. Value-added benefits totalled over $1.5 billion and a NASA R&D total investment in these 15 technologies of $64 million was found to stimulate an additional $200 million in private R&D."[23]

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[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/788725/LE-UKSA-Spillovers_in_the_space_sector-FINAL_FOR_PUBLICATION_050319.pdf

[23] https://www.researchgate.net/publication/8684297_Measuring_the_Economic_Returns_from_Successful_NASA_Life_Sciences_Technology_Transfers

Technology Transfer Value Creation with the Knowledge Transfer Network (KTN)
Contribution from Andy Bennett

"KTN create the diverse connections that drive positive change. Our knowledge and expertise enable innovators to transform bright ideas into real-world solutions. Our powerful industry and academic connections can guide entrepreneurs, start-ups and companies through the complex challenges of bringing new products, processes and services to market.

In the space sector we work with companies developing space technology and those who are deriving applications from space data, helping them to access new markets for their innovations.

An economic analysis of KTN's knowledge transfer activities showed that over 60% of the businesses reported that they had increased and/or expected to increase their investment in R&D and innovation, by on average £345k, as a direct result of their engagement with KTN clearly showing the value of these activities to the business. KTN helped form new commercial collaborations through introductions of which approximately 25% were between companies from different sectors. The aggregate funding secured by survey respondents following KTN advice was £81m."

Research Findings

Secondary Research

The secondary research, captured in the previous sections, has highlighted the value opportunity from technology transfer. There is evidence that pro-active technology transfer can add significant value with higher than average return-on-investments and societal and economic impacts.

It has also highlighted that technology transfer in the UK space sector is a known unknown, and despite moving away from accidental spillovers to proactive programmes, there is still a way to go (noting that innovation budgets are not broken out to specifically show technology transfer). Another gap highlighted by the secondary research is that, to date, research has been primarily focussed on government agency activity i.e. ESA, STFC and large organisations.

Secondary research findings in context of the assumed benefits of technology transfer outlined in the introduction to this study:

Category	Assumed Benefits	Perceived Impact	Findings from the Secondary Research

Sustainable Growth	Revenue Generation	**Positive**	• Captured as key benefit and reason for technology transfer • Limited research on the impact to revenue for those companies doing technology transfer
	New Market Creation	**Neutral**	• Recognised as a possible outcome from technology transfer
	Positive Environmental and societal impact	**Positive**	• Lives saved and impacted as a result of the technology transfer is one of the measures used to understand impact.
Risk Reduction	Portfolio of competitive products	**Positive**	• Recognised as a key outcome • Shown to prompt innovation, which is shown as 8.1% GVA (higher than the likes of telecommunications but lower than pharmaceuticals)[24]
	Portfolio of markets and applications	**Neutral**	• No specific research found
Positive Economic Impact	Job Creation	**Positive**	• Recognised as a key measure
	Export Growth	**Neutral**	• No specific research • Space shows a 36% export rate currently (higher than UK average but lower than EU export rate at 49%)[25]
	Attracting Inward Investment	**Neutral**	• No specific research

Industry Interview Feedback and Observations

In 2018/2019, MULTIPLY held a number of unstructured interviews with UK space companies (micro, small and medium sized companies only) to get their view on technology transfer.

The findings from this showed an appetite by all participants to pro-actively do technology transfer recognising the value opportunity, citing revenue growth as a primary driver, other reasons cited included:

- Demonstrating scalability to raise investment
- Accessing new geographic regions enabling cross-sell to their original product
- Brings learnings back into their core offering

[24] https://www.parliament.uk/documents/commons-committees/Exiting-the-European-Union/17-19/Sectoral%20Analyses/34-Space-Report.pdf
[25] https://www.parliament.uk/documents/commons-committees/Exiting-the-European-Union/17-19/Sectoral%20Analyses/34-Space-Report.pdf

- De-risks the business from disruption by removing reliance on only a few revenue streams
- Demonstrates innovation and leadership, boosting company and employer brand, building pride amongst employees improving retention, brand and competitive positioning.

Despite this the majority were not proactively doing technology transfer. This was based on a number of perceived and actual factors:

- Considered a distraction from core business
- Do not have the bandwidth to put time into non-core activity
- Do not have resources to invest into non-core activity
- Don't have in-house skills and experience
- Don't have access into other markets
- Considered too early in their growth to diversify
- Existing investors want them to focus on one core offering

Survey Response

The public survey was conducted in June 2020 to understand what technology transfer activity companies are doing in the space sector and why. Our survey was extended to other manufacturing and engineering businesses involved in (but not solely focussed on) the space sector in the latter part of June to get a comparison with other industry activity outside of the space sector.

We had 65 respondents with 40% of respondents coming from a purely space industry focussed company, 83% were located in the UK, with the majority of respondents from the South East and the Midlands *(Figure 4).*

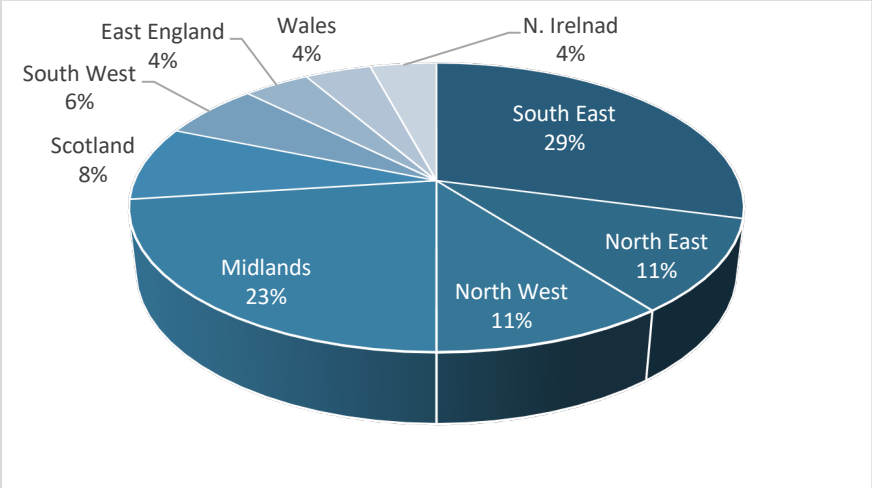

Figure 4: UK Regional Response

The majority (52%) of space focussed businesses did not have a dedicated technology transfer department or programme, however 48% reported doing technology transfer activity either formally or informally (responsively). This differed when we looked at all respondents including those not solely looking at the space sector and only 39% were not doing any technology transfer activity, indicating that the space sector is behind similar companies across different sectors *(Figure 5)*.

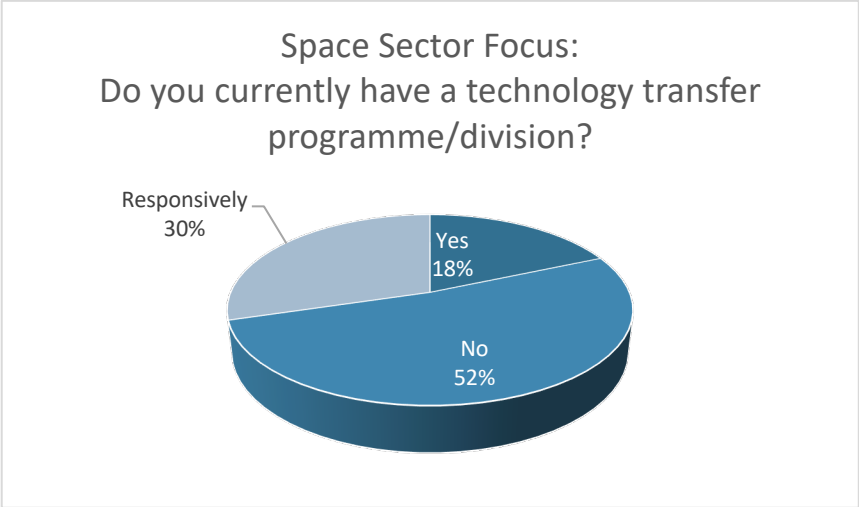

Figure 5: Space Sector Focus: Do you currently have a technology transfer programme/division?

"Clients don't realise they need it"
- Survey Respondent

Those companies who were proactively doing technology transfer and had a dedicated programme or department, cited demonstrating innovation and leadership most.

Whereas when taken in context of other companies not wholly focussed on space, revenue generation was the most cited reason to do technology transfer. *(Figure 6)*.

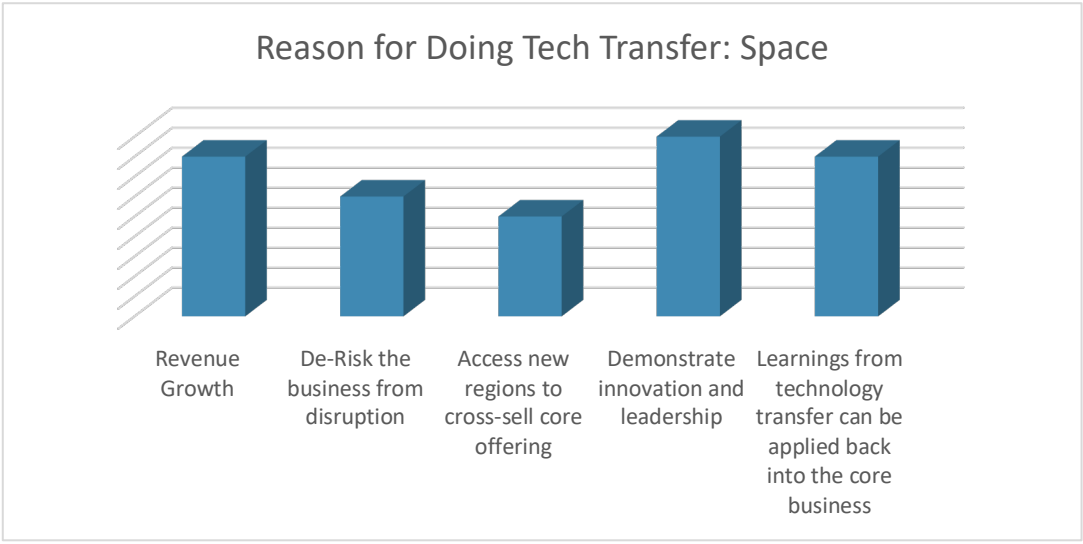

Figure 6: Reason for doing technology transfer

"…building company awareness and investor/customer confidence by demonstrating ability to achieve milestones and projects."
- Survey Respondent

Not having the bandwidth to undertake technology transfer activity was the primary reason companies didn't do technology transfer with 47% of respondents citing this reason. Not having the in-house skills and experience or concern it would be a distraction from the core were also highlighted *(Figure 7).*

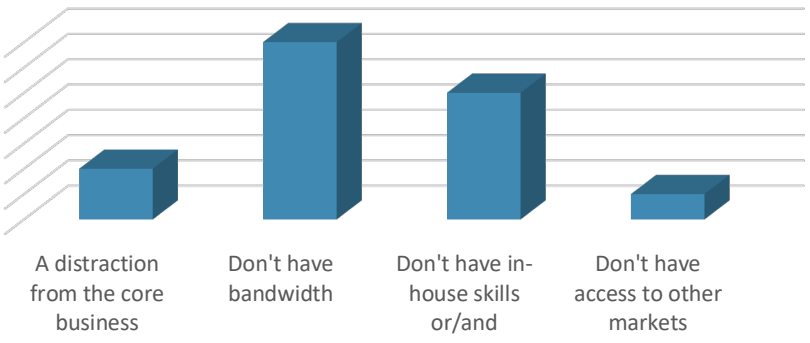

Figure 7: Reason for not doing technology transfer

"… [do technology transfer to] create advantage for the UK space sector."
- Survey Respondent

Recommendations

As highlighted in the report from London Economics[26] the determinants for spillover align with our findings that despite an appetite to do technology transfer companies don't feel they have the skills and bandwidth to do so. The secondary research has shown significant value opportunities through technology transfer, driving up GVA, impacting export, job growth and new emergent markets. Specifically, for the space sector, developing a commercially driven diversified portfolio has the benefit of de-risking the business, driving growth and building resilient, commercially sustainable businesses for the long-term.

The recommendations below are to take action. Action to stimulate industry-government discussion to develop support mechanisms that address the current barriers to B2B technology transfer and realise the potential value.

The Approach

Target:
Recommendation: Focus on SME-to-large companies (start-ups are too early stage and often unproven).
Why: maturity and reliability are key determinants for technology transfer.

De-Risk:
Recommendation: Leverage external support providers alongside training initiatives to build confidence and ensure robust processes to identify opportunities with a high likelihood of success.
Why: improve confidence, de-risk internal personnel and processes, by leveraging third party capability.

Build Capability:
Recommendation: Provide suitable investment channels to allocate skilled personnel externally (see de-risk) and internally to implement technology transfer programmes.
Why: investment channels are a key concern for implementing or/and making the decision to implement technology transfer activity

The Mechanisms

There are a number of mechanisms that can be implemented that would underpin the above approach:

Further Insight and Design

To inform policy and funding mechanisms, a more detailed study with a broader industry group to get another level of granularity and understand best practice should be conducted.

[26] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/788725/LE-UKSA-Spillovers_in_the_space_sector-FINAL_FOR_PUBLICATION_050319.pdf

This in turn would inform the design of support mechanisms and policy development. To enable the design and pilot of mechanisms, facilitation of surgeries, design pitches and innovation sessions provides a customer-led approach.

Policy Development

Private sector facilitators work collaboratively with government to provide support and advice. Provision of roundtables, showcases, collaborative study and policy integration. Bringing potential benefits to the National Space Council and other key government groups to embed in policy.

Financial Mechanisms

Early-Stage Technology Transfer (opportunities not identified or qualified):

- **National Technology Transfer Kick-Start Grant:** This is a low-level grant that requires UK recipient to leverage expertise from industry to kick-start a technology transfer programme to identify and validate and test opportunities with proposed market. This approach de-risks the business from uncertainty, providing a suitable investment channel, ensuring minimal impact to core business and resources.
    - Equivalent Example: ESA Permanent Open Call for Technology Transfer[27]

- **Technology Transfer Skills Voucher Scheme:** A measure giving financial aid to entrepreneurs to purchase training and advice to improve the quality of their businesses.
    - Equivalent Programmes: Flanders Innovation and Entrepreneurship*: Delivered by the Innovation and Entrepreneurship of the Flemish Government the SME E-Wallet is a measure giving entrepreneurs financial aid in the purchase of training and advice. This is part of the SME growth subsidy, a subsidy tool with which the Flemish government supports SMEs in achieving their own growth trajectory. This comes in a range of packages from under €10k for training and advice to €100k for pilot programmes. Although focussed on more traditional business growth support, the same principle could be applied to technology transfer opportunities which in itself is a business growth initiative.*[28]

Advanced Technology Transfer (opportunities identified or qualified):

- **Technology Transfer Loans:** These are government backed loans that enables the business to fund mid-late stage technology transfer activity. Taking a validated technology transfer opportunity to market. Removing internal barriers to implementation and decision making by removing impact to core-business cashflow and ensuring suitable funding in place for correct execution, setting them up for success, improving confidence and further reducing risk.
    - *Equivalent Example: British Business Bank: Bounce Back Loan Scheme*[29]

[27] https://www.esa.int/Applications/Telecommunications_Integrated_Applications/Technology_Transfer/Permanent_Open_Call_for_Technology_Transfer_Feasibility_Study_Proposals_and_br_Invitation_to_Tender_for_expert_pooling_issued

[28] https://www.vlaio.be/nl/andere-doelgroepen/flanders-innovation-entrepreneurship/subsidies-entrepreneurs/subsidies

[29] https://www.british-business-bank.co.uk/ourpartners/coronavirus-business-interruption-loan-schemes/bounce-back-loans/

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