UNIVERSITY OF BATH
SCHOOL OF MANAGEMENT

IAAPS: Building Bridges with Small and Medium Sized Firms

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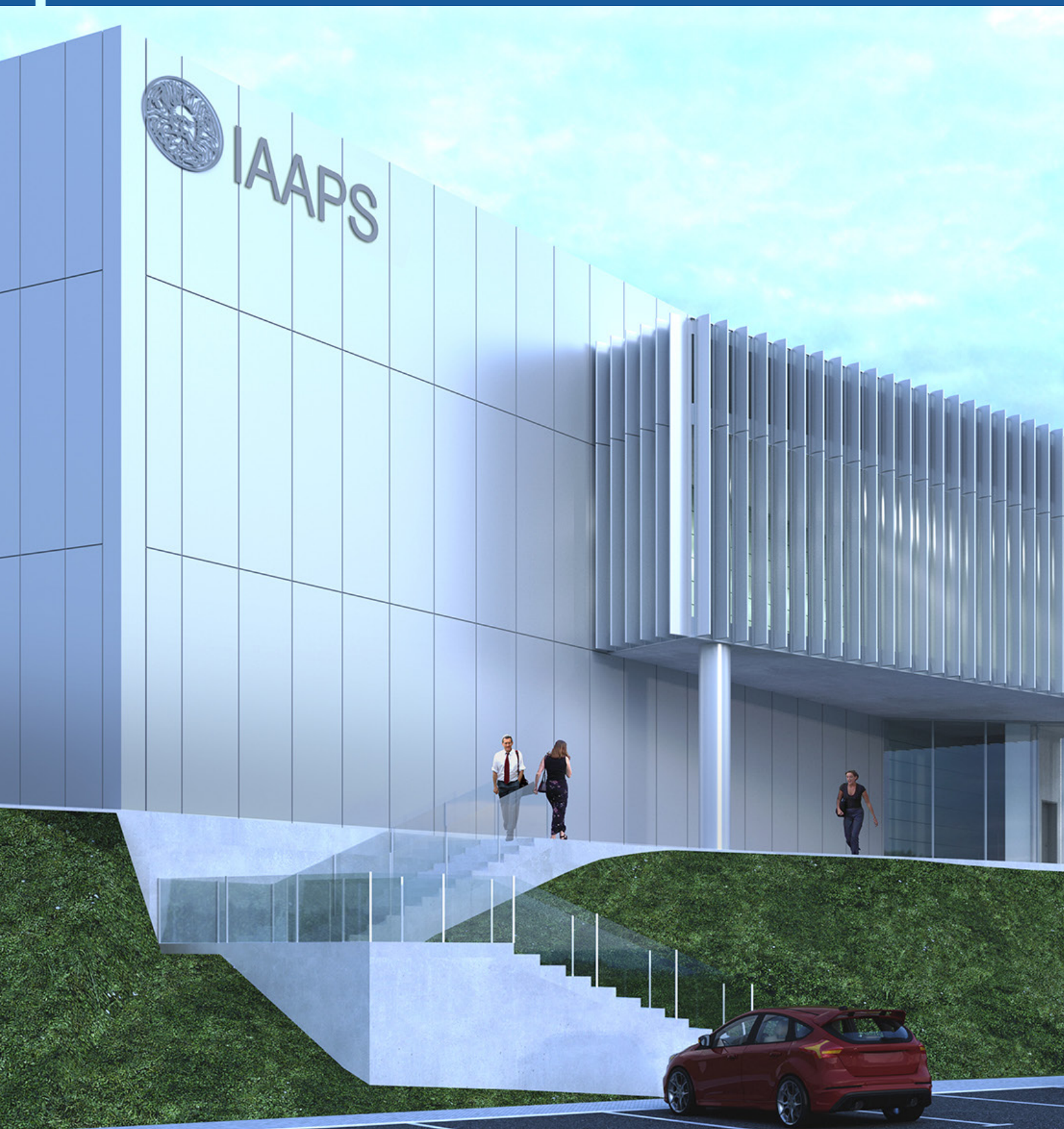

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Executive Summary

The University of Bath is currently in the process of making a formal bid to establish an Institute for Advanced Automotive Propulsion Systems (IAAPS) based at Bristol and Bath Science Park. IAAPS is a new research and innovation facility for advanced propulsion systems to deliver future generations of clean and efficient vehicles. The facility will enable deep insights to be made in the complex nature of transitioning to future Ultra Low Emission Vehicles, including more and full electrification propulsion systems as well as unique layouts and configurations for use in fully autonomous vehicles. In this regard, it is anticipated IAAPS will work closely with global corporate original equipment manufacturers (OEMs), universities and small and medium sized enterprises (SMEs). The ability of IAAPS to foster productive relationships and synergies with SMEs in this process is considered particularly important as it has the potential to lead to the development of a more vibrant and dynamic South West regional cluster.

This report drew upon academic literatures to highlight a wide range of potential relationships which could be nurtured between IAAPS and UK based SMEs in the automotive engineering and technologically related aerospace sectors. These potential relationships were explored in a survey issued to SMEs in these sectors in June and early July 2016. The results identify the extent to which the respondents would seek to establish these pre-identified relationships with IAAPS and the likelihood of (re)locating operations within the vicinity of the proposed facility. It highlights the reasons for SME hesitation about engaging with IAAPS, and offers some initial recommendations as to how IAAPS might address their concerns. In conducting this analysis, the report also discusses the dynamics of cluster development and relates insights from prior academic research to the IAAPS case.

In summary, the report finds:

1. Evidence that in both the UK automotive and aerospace sectors, SMEs perceive they could benefit from engagement with IAAPS. These primarily relate to gaining access to new information on the latest technologies, increasing their own profile, accessing industry networks and improved access to government funding. In the automotive sector, the high R&D intensity firms are statistically more likely to perceive these benefits than their low R&D intensity counterparts.

2. The involvement of an 'anchor tenant firm' in the form of a global OEM in the IAAPS project is likely to increase SME engagement with IAAPS. Attracting a global OEM leads to the perception by SMEs that IAAPS's research will: have more commercial value, increase the value of local knowledge networks and may provide opportunities for SMEs to enter new business networks.

3. However, the survey reveals the majority of SMEs were unaware of the wider concept of IAAPS and therefore lacked clarity as to how the proposed facility might be of benefit to their business. In part these responses may reflect that publicly accessible information was not available at the point of survey. Whilst a brief two page overview of IAAPS's ambitions and future facilities was issued with the survey, it is probable that many SMEs were unable to gauge how they might utilise the facility and how it differed from existing automotive propulsion centres without additional information. The responses may also reflect the limitations of the sampling frame.

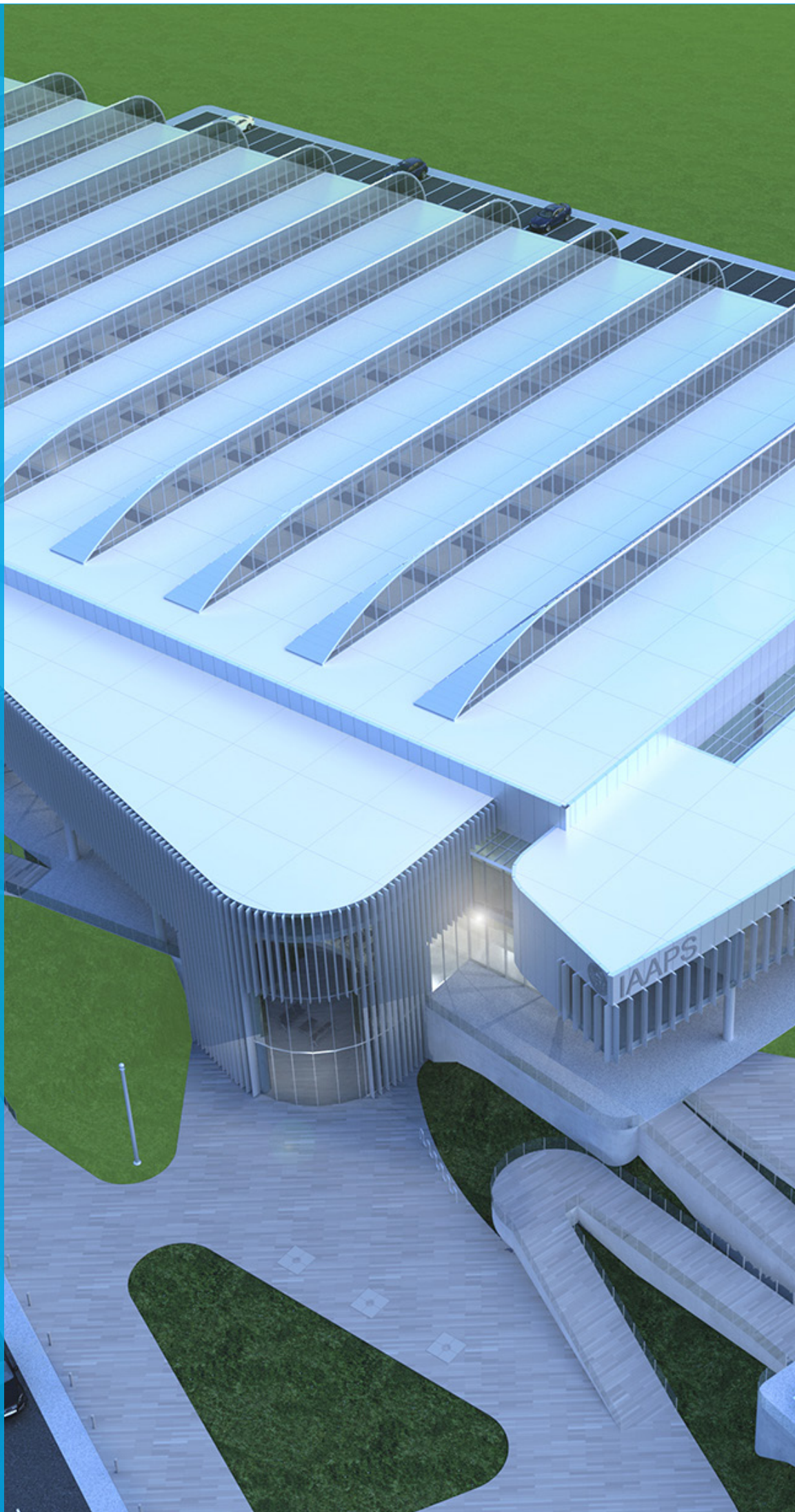
To allay these concerns and to strengthen the support for IAAPS, the report recommends:

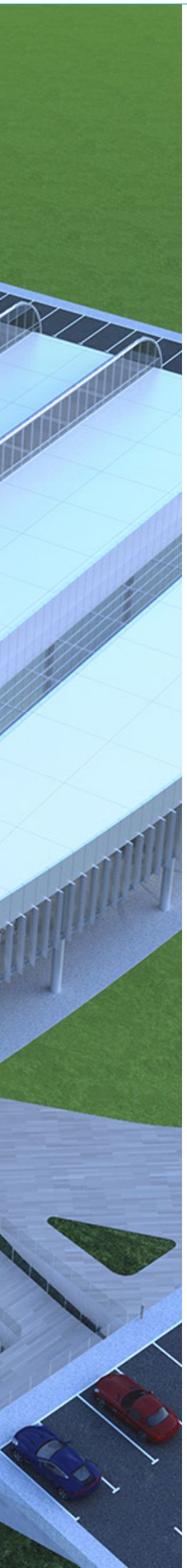
1. The IAAPS bid should provide more public information on the project, outlining its objectives, how it might engage with SMEs, build networks and add value. A starting point might be a networking event for SMEs held at the University of Bath in early autumn 2016 to showcase the related Powertrain and Vehicle Research Centre and indicate the type of equipment and facilities IAAPS might contain. The event should target the high R&D intensity SMEs who are statistically more likely to engage with IAAPS.

2. The IAAPS bid should include a pledge to support an onsite knowledge transfer team to help establish and strengthen existing local and international networks. A sub-team should specifically focus upon nurturing and building a technology focused SME network and facilitate SME engagement in IAAPS related projects and linkages to the OEM.

3. Initially, these network building initiatives should be provided free to SMEs. In the longer term, it may be possible for IAAPS to charge 'members' a baseline annual fee, entitling them to member benefits and a possible reduction in IAAPS 'user services'. Pricing here could be discriminatory to nurture relations with young firms, and will also depend upon IAAPS's reputation.

4. It is important for IAAPS and the University to demonstrate how it can provide the emerging cluster with an ongoing stream of relevant employee capabilities, not only in terms of specific technological skills but also managerial capabilities. In the latter regard, managerial competences might be integrated into relevant degree programmes and short executive development courses to enhance commercial awareness alongside engineering and technical skills.


IAAPS



1. Introduction

1.1 Overview

This report was commissioned in April 2016 by the University of Bath. It relates to the University's bid to establish a world class Institute for Advanced Automotive Propulsion Systems (IAAPS) at Bristol and Bath Science Park (BBSP). The report explores how IAAPS might contribute to and support the economic and technological activities of UK based, automotive engineering small and medium sized enterprises (SMEs) and SMEs in the technologically related aerospace sector. It also identifies the main reasons for SME hesitation about engaging with IAAPS and offers some initial recommendations as to how these may be alleviated. The analysis draws upon a survey of SMEs in the UK automotive and aerospace sectors, which was conducted in June and early July 2016 and was guided by previous academic work in this area.

1.2 IAAPS and BBSP

IAAPS is a proposal to build upon the University of Bath's highly renowned Powertrain and Vehicle Research Centre (PVRC), which encompasses 40 years of research excellence focused on improving the efficiency and emissions of both diesel and petrol engines. IAAPS is a new research and innovation facility for advanced propulsion systems, to deliver future generations of clean and efficient vehicles. The facility will enable deep insights to be made in the complex nature of transitioning to future Ultra Low Emission Vehicles, including more and full electrification propulsion systems as well as unique layouts and configurations for use in fully autonomous vehicles. IAAPS will work closely with corporate manufacturers, SMEs and other universities. IAAPS will be a 10,000sqm facility, with a capital cost of £50m and based at BBSP.

BBSP opened in 2011 and is located in the Emerson's Green Enterprise Area, close to the M4 between the cities of Bristol and Bath. On site is the main BBSP "One" building, with a forum, central reception and meeting space area open to all, with additional meeting rooms for hire. There is also an Innovation Centre, providing office space for start-up firms and small teams along with hot-desking and virtual offices. The Grow-On Centre offers flexible and adaptable workspace for small firms to grow into as they expand. There are currently over 50 tenants within the BBSP One building, and these are mainly high-technology based firms. BBSP operates a Gateway Policy, which describes the preferred occupier as science, research and technology based firms. The BBSP site also hosts the National Composite Centre (NCC) - one of Innovate UK's ten designated catapult centres – which specialises in the design and manufacture of composites for use in science and industry. There are currently more than 40 tenants in the NCC, including Airbus, BAE systems and Rolls Royce. It is anticipated that IAAPS, the NCC and their partners could stimulate complementary opportunities for technological development of international significance.

1.3 Motive for the Study

It is known that the presence of world-class research from universities can be a contributor to regional and national economic growth. The emergence of successful industrial clusters such as those surrounding Stanford University in Silicon Valley, California and Cambridge University in the UK are testament to this. Industrial clusters support the development and growth of firms by providing positive spillovers in the form of transport and communication links, access to a large pool of trained and educated labour, and to knowledge and business networks. Specifically, the proximity of SMEs to leading universities in clusters means they potentially have direct access to university research outputs in the form of graduates, R&D and training and also possibly access to specialised testing and laboratory equipment. Universities themselves can also spin-out new firms into the local cluster and contribute to regional economic growth and development. Given the University of Bath and IAAPS intend to build close links with local high-tech SMEs and beyond, the question arises: how extensive do UK based SMEs in the automotive and aerospace sectors perceive their likely future engagement with IAAPS to be and how this can support a regional cluster? This is the main purpose of this report.

1.4 Structure of the Report

The remainder of this report is set out as follows.

Section 2 provides an outline of the benefits of clusters, cluster dynamics and networks.

Section 3 provides an overview of the sampling frame, sample and methodological approach.

Section 4 presents the survey results separated by sector, and categorised by firm R&D intensity. The results focus upon:

- SME perceived benefits of engagement with IAAPS, and barriers to closer engagement.
- How attracting global Original Equipment Manufacturers (OEMs) to IAAPS alters the perceptions of SMEs.
- SME location decisions in relation to the proposed IAAPS facility.

Section 5 provides a discussion of the results.

Section 6 summarises the main findings, and provides initial recommendations on how IAAPS may initiate stronger engagement with SMEs.

2. Clusters, Cluster Dynamics and Networks

2.1 Cluster and Cluster Dynamics

A regional cluster is generally defined as firms, suppliers and associates in the same or related industries which are located in a specific geographical area (Porter 1998). When regional clusters are industrially or technologically focused, firms resident in the region are generally perceived to benefit from productivity enhancing advantages such as access to a local skilled labour pool, access to common infrastructure and transport networks and also links to local industry research institutes and trade associations. In addition, the close proximity of numerous firms may also enhance firm productivity and the cluster's growth path in two ways. First, proximity may spur greater competition between co-located firms, leading to production efficiencies and/or technical advances. Secondly, and somewhat paradoxically, the close proximity of firms may also facilitate more inter-firm linkages, collaboration and higher social capital within the cluster, enabling firms to exploit synergies and benefit from knowledge transfer. This may lead to the emergence of beneficial common codes of conduct, practices and standards but also cluster specialisation and higher levels of innovation. This perceived virtuous 'cluster dynamic' is partly the reason why the development of clusters has, since the late 1980s, become part of regional policy lexicon.

The cluster dynamic may be enhanced if local firms form relationships with local research intensive universities. The universities themselves may be a source of entrepreneurial start-ups and spin-out firms to the region which perpetuate the cluster's growth. Even in the absence of spin-out opportunities, local research-intensive universities can provide numerous benefits to firms in the form of highly educated graduate employees, access to world-class researchers, access to specialized equipment and facilities and cutting edge knowledge. However, this 'cluster dynamic' is not guaranteed and whilst there is much evidence to suggest that policy support at both regional and national level is a facilitating factor for the establishment of a cluster, it cannot ensure the cluster will grow, be dynamic or successful. The cluster needs to evolve and connect with other networks. The notion of 'networks' and its relationship to regional clusters is leading to a deeper understanding of the role of regional clusters in value creation for commercial organisations.

2.2 Networks

A network is distinct from a cluster in that the latter in its purest form merely signals the benefits that arise from positive externalities and spillover effects that occur within a particular defined physical geographic space. The actors within that space do not necessarily form networks. For example, export processing zones are geographic areas located near major ports in which firms cluster to benefit from better transport and communication links to hauliers and freight transporters and export related tax concessions, but the co-location of firms in these zones does not lead to the formation of networks for knowledge sharing or capability building. When organisations within a geographic space connect together to form networks, the benefits of the cluster are multiplied. However, organisations can also form networks across countries and continents unconstrained by a physically defined geographic space i.e. networks can exist in the absence of a cluster. IAAPS must ensure that it encourages the growth of networks around (and beyond) its location, and not just be one organization among a geographic cluster of organisations. The potential for network linkages to be created with the NCC and the tenants of BBSP such as the Centre for Modelling & Simulation (CFMS) are a good starting point for these networks.

The underlying nature of the network IAAPS can create around itself is likely to be a knowledge-based one. Generally knowledge, particularly new or novel knowledge, is perceived to be 'sticky' – difficult to transfer and best done face-to-face. Hence within the geographic proximity of clusters, connections between organisations can lead to the creation of 'knowledge networks'. Indeed the benefit of a research intensive university to firms within a regional cluster is the impact it has on the focus, quality and quantity of knowledge generated and shared within a region in its role as knowledge creator. The university also plays a key role in the creation of local social networks as the direct interaction of the university with a variety of organisations, also enables it to facilitate connections between these organisations through conferences, public lectures, or introductions; it can also act as a 'knowledge broker' (Levy and Reid 2011). Indeed, turning scientific or engineering knowledge into useful applications is facilitated by the interaction and establishment of relationships between the university and firms (of all sizes).

For SMEs in particular, the access to university resources is regarded positively from a policy standpoint as it means SMEs can engage in R&D projects or obtain access to expensive equipment and facilities which they are unable to acquire independently. On the other hand, a point not observed so well by policymakers is that SMEs may find it difficult to enter into relationships with local universities simply because SMEs may be unaware of what opportunities university relationships can offer. This can be mirrored by SMEs also being unaware of what they need and/or of the potential synergies of engagement with universities. If SMEs do not recognize their shortcomings in this regard, they may not realise that the university is willing and able to provide assistance. Even if they do realise, the SME may be faced with a lack of clarity about who they should make contact with and find the search task overwhelming (Weiss and Minshall 2014). Additionally, SMEs may lack resources to invest in relationship building with external organisations and the cost of access to university resources maybe out of their reach. The mere size of an SME also means its ability to value, assimilate and apply new knowledge (i.e. its absorptive capacity (Cohen and Levinthal 1990)) even if it knows it is available from a university may be severely limited. The presence of an 'anchor tenant firm' can help with many of these issues.

An anchor tenant firm is a large, locally present firm that is generally heavily engaged in R&D and has the absorptive capacity to apply new knowledge in a particular technological area (Agrawal and Cockburn 2003). The presence of a large R&D intensive firm might be perceived negatively; dominating the IAAPS research agenda and crowding out SMEs from the local region by attracting the best employees with higher salaries and more attractive career trajectories. On the other hand, when the large firm acts as an anchor tenant and engages directly with the university as a significant 'consumer' of university research,

it is possible that it creates positive mutual benefits. For example, the consumption of university research by a large firm may encourage the set-up of professional knowledge transfer offices to help transition university research output into knowledge input that might be commercialised. In turn, these professional services can then be extended to SMEs, they may be even cross subsidized by the contracts with larger firms thereby lowering the cost of access to university knowledge for SMEs. Therefore, the presence of anchor tenant firms and their relationships with local universities help clusters to become regional systems of innovation in which the local university's research is more likely to be absorbed and stimulate regional industrial R&D more widely.

The presence of an anchor tenant firm also helps the knowledge network in a region become connected to a business value network in the region and beyond. For businesses, the point of accessing knowledge is to create value for customers, to use the knowledge to develop commercialisable products and services and deliver these to the market. Without the ability to do this, the knowledge derived from knowledge networks in regional clusters has little 'value' in and of itself and the economic performance of the regional cluster may be limited (Clarysse et al. 2014). Value creation is not something the university can normally directly assist with. Firms need to develop 'business networks' rather than knowledge networks to do this. Business networks may be local, but business networks which are international offer more opportunities for commercial growth. However, many SMEs are regionally based and can find it difficult to establish a wider business network due to their limited resources of time and money to travel and make the connections they need. The presence of an anchor tenant firm within the region can provide an incentive for local SMEs to signal their desire and capability to become part of the anchor tenant firm's wider business oriented value network. Where the technological specialization of the cluster is in a novel area, such as that relating to low carbon propulsion, the value network of the anchor tenant firm may be fairly open or in flux for a period so opportunities for intelligent SMEs with the right capabilities may be all the greater.

The survey questionnaire developed for this research sought to build upon the current academic understanding of regional clusters, knowledge networks and business networks. In particular, it addressed the potential attractiveness of the university's IAAPS centre (as the cornerstone of a knowledge network) for SMEs, and how this might change with the involvement of a large OEM who could act as the anchor tenant firm (with the dual role of major 'consumer' of IAAPS research and as the anchor tenant firm of a business network).

3. Methodology

3.1 Sampling Frame and Survey Design

The data for this study was collected from a survey of just over 1,100 small and medium sized firms operating in the UK automotive and aerospace sectors. While IAAPS will primarily focus upon propulsion systems for the automotive industry, it is envisaged there will be strong synergies with technologically proximate sectors particularly aerospace. The sampling frame of firms was drawn from the membership directories of the respective main industry trade associations – The Society of Motor Manufacturers and Traders (SMMT), the Aerospace, Defence, Security, Space Group (ADS) and the West of England Aerospace Forum (WEAF). The directories provided contact and background information on member firms operating at the 4-digit Standard Industrial Classification (SIC) in both sectors.

The survey was addressed to the Managing Director of each firm and was administered by post (with an option to complete online) – during June and the first half of July 2016. A two-sided leaflet explaining the concept of IAAPS, its remit and facilities was also sent out with each survey providing information on the proposed facility. To elicit a higher response rate, respondents were offered the opportunity to enter a free prize draw[1]. Non-respondents were chased by telephone and reminder letters during the survey period. The survey itself included some background questions relating to the previous three years of trading (2012-2015), such as firm size, supply chain status, and firms' R&D intensity. In addition, one section of the survey asked several questions on their projected utilisation and the likely benefits of IAAPS in two different scenarios: one without the presence of an OEM and one with an OEM. Survey questions were largely based upon other surveys used in previous academic studies and where applicable utilised a 7 point Likert scale.

3.2. Sample

In total, 107 completed responses were received, representing a 9.7% response rate. This response rate is slightly lower than may have been expected, although this is largely explained by the relatively short window for the survey (6 weeks) and the fact the survey was launched during the early summer, when several Managing Directors were on vacation. The sample comprises 56 responses from automotive SMEs (a 14% response rate), with 15 of these designated as first tier suppliers, 14 as second tier suppliers and 27 sub-tier suppliers respectively. In the aerospace sector, 51 responses (7.7% response rate) were received, 8 being first tier suppliers, 11 second-tier and 32 sub-tier suppliers.

3.3 Presentation of Survey Results

The survey results are summarised in tabular form and separated by sector, with responses also categorised by firms' self-reported R&D intensity. Categorising firms by R&D intensity not only facilitates greater comparison of responses, but also acts as a proxy for firms' current research capabilities and allows alignment of these with their own perceptions of IAAPS. This seems relevant in the context of IAAPS being a high technology facility. R&D intensity is measured using the proportion of firms' turnover spent (in terms of direct budget and/or staff time) on Research and Development activities over the period 2012-2015. Firms whose R&D expenditure ratio was greater than 10% are categorized as having 'high' R&D intensity and those with 10% and below being categorized as having 'low' R&D intensity. A set of 3x2 contingency table χ^2 (chi-square) statistical tests[2] are utilised to assess whether firms' perceptions of IAAPS are statistically contingent on their own level of R&D intensity. Where significant statistical contingencies exist, the relevant boxes in the tables are shaded.

[1] Employing a prize draw as an 'incentive' to participate in survey research raises the issue as whether it exerts undue influence on potential participants' decisions about whether to take part in the research, which may distort the sample (Alderson & Morrow, 2004). However, such 'prize draws' are successful in generating higher response rates and thus reduces non-response bias, and increases the sample quality. This can help to achieve a sample that is more representative of the population being studied than could otherwise be achieved (Groves and Peytcheva, 2008).

[2] A contingency table is a matrix providing a basic description of, and a means to analyze, the statistical relationship between two (or more) variables. For example, in this report, the two variables are i) firms' level of agreement to particular statements reported in 3 columns and ii) the firms' self-reported levels of R&D intensity reported in 2 rows. A chi-square χ^2 test is then conducted to check whether these two variables are statistically contingent on one another. If there is no contingency, the variables are independent. For further details on $\chi 2$ contingency table tests, see Lewis-Beck et.al (2004).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4. Survey Results and Analysis

4.1 Perceived Likelihood of Working with IAAPS

Respondents were asked to rate on a 7 point Likert scale, the extent to which they perceived their firm might utilize and benefit from the provision of certain opportunities, resources and services by IAAPS. The responses are clustered into three columns which are low level (for responses marked 1-3), mid-level (response of 4) and to a higher level (for responses marked 5-7) and in rows, categorised by firms' self-reported levels of R&D intensity (High or Low).

The results are presented in Table (1), where for each statement there is a 3 x 2 contingency grid. In reading Table (1), it can be seen – for example in the first statement – that in the automotive sector there are 23 out of 49 firms which have a high level of agreement that they would benefit from IAAPS because of 'access to government funding'. Of these 23 firms, 15 are categorized as being highly R&D intensive and 8 being of low R&D intensity. There are 6 firms (3+3) which are neutral (the mid-score) on this statement. Finally, 20 firms respond to a low level of agreement on this statement, of which only 6 are high R&D intensity firms. Moreover, in this case the χ^2 statistic is significant (at a 10% confidence level) suggesting that the differences in automotive firms' responses to this statement are contingent on their R&D intensity. It appears high R&D intensity automotive firms are statistically more likely to agree that they may benefit from accessing government funding (via IAAPS) than low R&D intensity automotive firms.

Overall, firms in both sectors indicate the main benefits they perceive they will gain from IAAPS as being (in rank order):

1. Access to and sharing of information relevant to latest technologies.
2. Scope to enhance their own company image.
3. Access to a wider network of industry contacts.
4. Scope to enhance supply chain relationships.
5. Access to government funding.

These are all very broad, non-specific benefits. In the automotive sector, both 'enhancing company image' and 'enhancing supply chain relationships' were statistically contingent upon R&D intensity, with high R&D intensity firms generally more positively perceiving these benefits vis-à-vis their low R&D intensity counterparts. This was not the case in the aerospace sector, where responses on these criteria are not statistically contingent on R&D intensity i.e. the responses are independent. In both sectors, most SMEs did not perceive they would engage with IAAPS for its proposed specialised facilities (vehicle testing, climatic vehicle performance facilities, powertrain facilities), or the university specific knowledge transfer mechanisms such as training, graduate engineering students on projects, staff secondment and shaping the research agenda. This is highly likely to be because they did not feel as though they had sufficient information about IAAPS to make this decision. In the automotive sector, these responses were contingent upon R&D intensity; in short, low R&D intensity firms were statistically less likely to engage with IAAPS on these criteria than high R&D intensity firms. Again, in the aerospace sector – with the exception of staff secondment opportunities – the responses were statistically independent of R&D intensity (See Table 1).

One might expect the response from large corporations (not surveyed) to be significantly different in this regard as large firms have the resources, absorptive capacity, technological and managerial capabilities to use IAAPS in these more specialized ways, which SMES lack. This suggests that if these facilities and services are to be utilised by SMEs, then IAAPS will need to convey more clearly and convincingly to SMEs how IAAPS can help them deliver technical advances and productivity gains. In the first instance, this requires further information on the types of facilities that will be available and possibly demonstration events with selected firms. In this regard, high R&D intensity automotive firms might be identified as early candidates for such activities, given their relatively more positive response to the IAAPS proposition.

While the intent of the research was primarily to discover if SMEs would engage with and utilise IAAPS's facilities, existing SMEs may also see IAAPS as an opportunity to provide products and services to a new client (i.e. engage with IAAPS as a supplier rather than a user). The survey therefore asked whether firms might seek to provide IAAPS with products and services. Of these, 20 automotive (35.7%) and also 20 aerospace (39.2%) firms indicated they would be interested in doing so. Firms indicated a range of products and services that might be provided including powertrain concept design and advanced analysis services, prototype heat exchangers, software products aimed at the fuels and internal combustion engine industry segments and collaborative R&D.

4.2 Barriers to SME Involvement in IAAPS

The survey also asked respondents to identify several factors that may prevent them from becoming involved with IAAPS. The responses are reported in Table (2).

The most important factors in both sectors relate to firms being 'unsure of what they might contribute' and 'being unaware of the services IAAPS could provide'. This is unsurprising and relates in part to the lack of detailed information on IAAPS's proposed facilities and how these might specifically be utilised by SMEs. Greater public engagement and outreach activities by IAAPS, particularly to SMEs, can potentially overcome some of these barriers. Additionally, firms identified their own internal constraints (finance, personnel and time) as inhibiting factors. These barriers are more difficult to overcome, particularly as we enter a period of economic uncertainty (e.g. Brexit) where firms are more cautious about making additional commitments. In this regard, IAAPS will need to carefully nurture relationships with SMEs to facilitate collaboration. This may require, among other things, and at least in the short term, IAAPS providing opportunities for public engagement and social networking at low cost to participants and even potentially subsidizing the use of its facilities for a period.

Table 1. SME perceptions of their future use of and benefit from IAAPS

The following is a list of services (and potential benefits) the Institute of Advanced Automotive Propulsion Systems (IAAPS) intends to provide. To what extent do you think your firm would utilise and benefit from these?	R&D Intensity	Automotive Agreement			Aerospace Agreement		
		Low	Mid	High	Low	Mid	High
Access to government funding	Low	14	3	8	18	6	11
	High	6	3	15	4	1	5
Access to and sharing of information relevant to latest technologies	Low	9	3	13	18	5	12
	High	3	5	15	4	2	4
Support for own firm R&D and design activities	Low	13	3	9	22	1	11
	High	10	3	10	6	1	3
Scientific, Technical Advice & Support	Low	14	4	7	19	5	11
	High	10	3	11	6	1	3
R&D activities in Power Transmission carried out for the benefit of wider automotive industry	Low	18	3	4	23	5	6
	High	12	3	8	8	1	1
Use of Electric Propulsion laboratory	Low	21	1	3	29	2	3
	High	16	2	5	9	0	1
Energy Storage Laboratory	Low	21	2	2	26	4	4
	High	17	2	4	8	0	2
Gas Dynamics and Fluid Flow Laboratory	Low	23	1	1	30	2	2
	High	18	1	3	8	0	2
Vehicle Testing facilities	Low	21	0	4	31	1	2
	High	12	5	7	9	1	0
Climatic vehicle Performance Facilities	Low	24	0	1	33	1	1
	High	13	3	6	10	0	0
Powertrain Research facilities	Low	22	1	2	31	1	2
	High	14	2	7	7	2	1
Access to a wider network of industry contacts	Low	9	5	11	10	5	19
	High	8	1	15	5	0	5
Use of IAAPS linked graduate engineering students on research projects	Low	20	1	4	27	1	6
	High	8	4	11	8	1	1
Provision of training facilities and/or specific training courses	Low	16	5	3	21	6	7
	High	14	2	7	7	2	1
Industry Benchmarking	Low	16	4	5	19	7	8
	High	8	6	9	8	2	0
Staff secondment opportunities with IAAPS	Low	21	0	4	27	1	6
	High	13	4	5	7	3	0
Shaping the research agenda at IAAPS	Low	23	1	1	29	4	1
	High	12	4	7	8	0	2
Scope to enhance supply chain relationships	Low	12	5	8	16	4	15
	High	6	3	14	4	2	4
Recruitment Opportunities (via Knowledge Transfer Partnerships etc.)	Low	15	9	1	27	2	6
	High	7	4	12	5	2	3
Scope to enhance company image	Low	10	5	10	16	6	13
	High	6	0	18	6	1	3

Table 2. Deterrents to SMEs becoming involved with IAAPS

Automotive	No. of firms	Aerospace	No. of firms
Existing Automotive research centres satisfy our needs (e.g. MIRA, Warwick APC)	9	Existing Automotive research centres satisfy our needs (e.g. Qinetiq, Warwick APC)	3
Unaware of the services IAAPS could provide	18	Unaware of the services IAAPS could provide	14
Perception that IAAPS is too focused on 'blue sky' research	10	Perception that IAAPS is too focused on 'blue sky' research	8
Do not know how to establish a connection with IAAPS and its network	9	Do not know how to establish a connection with IAAPS and its network	10
Our own Technical Knowledge Constraints	1	Our own Technical Knowledge Constraints	3
Unsure of what we might contribute	26	Unsure of what we might contribute	14
Financial Constraints	17	Financial Constraints	11
Personnel Constraints	11	Personnel Constraints	9
Time Constraints	9	Time Constraints	14
Other	3	Other	5
		We do not perceive any overlaps between our activities in aerospace and this aspect of the automotive sector	14

4.3 The Influence of Global OEMs Engagement with IAAPS on SME Perceptions

Respondents were also asked a series of questions as to whether they would be inclined to become more or less involved with IAAPS if a global automotive OEM was also closely associated with the facility. Aerospace firms were also asked an additional similar question in relation to (hypothetical) involvement with Airbus Industrie which has a European hub in nearby Filton. The survey results are presented in Tables (3) and (4), and again categorised by firms' R&D intensity.

The results highlight the importance of attracting global OEMs to work with IAAPS and their positive spillovers on SMEs as the number of firms in strong agreement with the 'more inclined' statements are in the majority. From Table 3, the 5 responses with the strongest support for "*Our firm would be more inclined to become involved with IAAPS because…*" are (in rank order):

1. The presence of a global OEM would make local networks more valuable for knowledge sharing.
2. We perceive a potential opportunity to enter the OEM's existing value networks.
3. We perceive a potential opportunity be part of the future business ecosystem of the OEM in this new technological area.
4. We perceive its research direction would be influenced by key industry practitioners such as the OEM.
5. We perceive it to be a potential way to access competences the OEM has which we do not e.g. marketing and distribution.

It seems that an OEM's involvement with IAAPS would increase the perceived value to be gained by knowledge sharing within networks associated with IAAPS. In the automotive sector, this was statistically contingent on R&D intensity, with high R&D intensity SMEs more likely to see 'local networks enhanced through more valuable knowledge' and benefiting from being 'part of the future business eco-system' than low R&D Intensity firms (see Table 3). The potential to enter the OEM's existing networks are also highly attractive to both high and low R&D intensity

Table 3. SME perceptions of their future use of IAAPS and benefits from having a global automotive OEM nearby

If IAAPS was able to attract a global automotive OEM to locate research facilities in the region to what extent do you agree or disagree with the following?	R&D Intensity	Automotive Agreement			Aerospace Agreement		
		Low	Mid	High	Low	Mid	High
Our firm would be more inclined to become involved with IAAPS because we perceive its research direction would be influenced by key industry practitioners such as the OEM.	Low High	10 5	5 7	10 12	16 5	5 0	13 5
Our firm would be less inclined to become involved with IAAPS because we perceive its research direction would be dominated by key industry practitioners such as the OEM.	Low High	17 14	5 4	2 5	23 8	5 0	5 2
Our firm would be more inclined to become involved with IAAPS because the presence of a global OEM would make local networks more valuable for knowledge sharing.	Low High	9 2	6 3	9 18	12 5	6 1	16 4
Our firm would benefit from being in the same region as IAAPS because we perceive networking with OEM locally will enable us to learn about emerging trends and demands for our output from countries beyond the UK.	Low High	6 7	8 7	10 9	15 7	7 2	12 1
Our firm would be more inclined to become involved with IAAPS because we perceive it to be a potential way to access competences the OEM has which we do not e.g. marketing and distribution.	Low High	9 7	3 7	12 8	17 7	7 2	10 1
Our firm would be more inclined to become involved with IAAPS because we perceive a potential opportunity to enter the OEM's existing value networks.	Low High	6 5	6 4	12 14	14 4	3 0	17 6
Our firm would be more inclined to become involved with IAAPS because we perceive a potential opportunity be part of the future business ecosystem of the OEM in this new technological area.	Low High	12 4	4 5	8 14	14 5	6 1	14 4
Our firm would benefit from being in the same region as IAAPS because we perceive the OEM's presence will attract higher skilled labour more generally, which we may be able to benefit from.	Low High	12 10	6 8	6 5	16 7	7 2	11 1
Our firm would suffer from being in the same region as IAAPS because we perceive the OEM's presence will attract most of the higher skilled labour available which depletes our recruitment pool.	Low High	17 12	2 7	5 4	25 8	5 0	4 2
Our firm would benefit from being in the same region as IAAPS because we perceive the OEM's presence will attract investor interests more generally, which we may be able to benefit from.	Low High	11 7	5 10	8 6	16 5	6 3	12 2
Our firm would benefit from being in the same region as IAAPS because we perceive the OEM's presence will attract professional ancillary service companies (law firms, financial intermediaries etc.) which we may also be able to use.	Low High	14 11	5 7	5 5	17 9	11 0	6 1

Table 4. Aerospace SME perceptions (only) of their future use and benefits of IAAPS if a research relationship with Airbus Industrie were to be established

If IAAPS was to establish a research relationship with Airbus Industries in the region, to what extent would you agree or disagree with the following?	R&D Intensity	Aerospace Agreement Low	Mid	High
Our firm would be more inclined to become involved with IAAPS because the relationship with Airbus would signal its research to have the potential to contribute to the aerospace industry.	Low High	9 3	7 0	19 7
Our firm would be more inclined to become involved with IAAPS because its link to Airbus would make local networks more valuable for knowledge sharing.	Low High	9 3	7 0	19 7
Our firm would be more inclined to become involved with IAAPS because we perceive it to be a potentially new way to access competences Airbus possesses which we do not.	Low High	16 4	8 1	11 5
Our firm would be more inclined to become involved with IAAPS because we perceive it would offer a potential opportunity to enter Airbus's existing value networks.	Low High	14 4	4 2	17 4
Our firm would be more inclined to become involved with IAAPS because we perceive it would offer a potential opportunity be part of Airbus's future business ecosystem.	Low High	10 3	7 1	18 6
Our firm would benefit from being in the same region as IAAPS because we perceive its links to Airbus will attract investor interests more generally, which we may be able to benefit from.	Low High	16 5	4 2	15 3

automotive firms in approximately equal numbers. Both types of firms were equally as likely to become more engaged with IAAPS if it were working with a major automotive OEM because of the confidence the OEM's involvement would signal about the technological direction of the research being done by IAAPS and its potential commercial viability. Finally, a greater proportion of low R&D intensity automotive firms (50%) than high R&D intensity firms (39%) indicated they would be more attracted to becoming involved with IAAPS as the OEM might provide a way for them to access competences they did not possess (e.g. in marketing and distribution). This may reflect that low R&D intensity firms are more likely to be in the post development, production/engineering stage of the innovation process and looking to sell physical products, unlike the high intensity R&D firms who are likely to be closer to the research end of the innovation process developing specialized expertise and knowledge.

Not surprisingly, firms in the aerospace sector had less interest in a potential IAAPS-global automotive OEM association. However, 23 firms (out of 44) indicated it opened up the possibility of access to the OEM's production networks, while 20 firms saw the benefits of enhancing local networks for knowledge transfer. This may indicate some potential for network synergies and technological convergence between the two sectors. In Table (4), it is also clear that a close relationship between IAAPS and Airbus Industrie would be a considerable attraction to aerospace firms. Such a relationship would signal that research activities at IAAPS were of relevance to the aerospace sector thereby increasing the likelihood of these firms engaging with IAAPS.

Overall, Tables (3) and (4) indicate that IAAPS working with global OEMs was not perceived negatively (i.e. not perceived to be dominating the research direction of IAAPS, nor crowding out SMES from accessing skilled labour). Across both sectors, it will be crucial for IAAPS to demonstrate that it will seek to engage and work with global OEMs in ways which have positive benefits for the SMEs who are engaged with IAAPS. First, the involvement of OEMs act as a signal that IAAPS research is of interest to the major players in the automotive and aerospace industries and hence has potential commercial value (rather than only of scientific value to researchers and academics). This increases the perceived value of the knowledge networks which may form around IAAPS in the local region.

Table 5. Reasons preventing firms from re-locating/locating a unit close to the IAAPS centre

	Number of Responses	
	Automotive	Aerospace
Insufficient funds	7	3
Relocation costs	12	9
Satisfied with existing location	34	26
Already in close proximity to BBSP	6	11

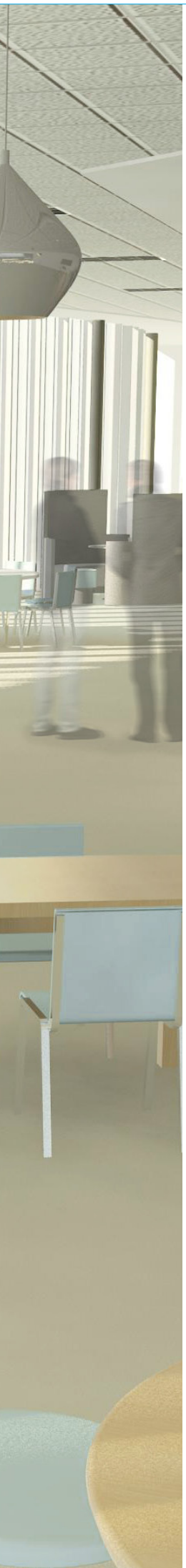
Moreover, IAAPS should seek to undertake the role of knowledge broker through outreach activities and create a designated IAAPS SME facilitator team through which firms can be introduced either formally, or informally through specific network events. Second the involvement of OEMs with IAAPS provides a potential opportunity for SMEs to signal their technological capabilities and managerial competencies to the OEM and find a route into the OEM's existing and/or future business networks. Thus while the creation of IAAPS will attract SMEs, their engagement with IAAPS would be enhanced by its partnerships with and use by well-established OEMs.

4.4 SME Location Decisions in Relation to the Proposed IAAPS Facility

In this final section, the survey sought firms' opinion on the likelihood of re-locating their existing operations and/or locating a unit close (within 50 miles) to the proposed IAAPS facility.

In total 6 (10.7%) automotive firms (of which 4 are high R&D intensity) and 3 (5.9%) aerospace firms (all low R&D intensity) indicated they would consider establishing a unit close to IAAPS. Several factors preventing firms from re-locating are documented in Table (5).

These results are unsurprising. The majority of firms are currently satisfied with their existing location (Table (5)). Of course, these satisfaction levels are being expressed with respect to the known advantages of their current locations, as against their existing (and presumably lesser) knowledge of BBSP and the limited information that was currently available to them regarding IAAPS.



5. Discussion

Universities have a critical role in the triple helix model of industrial clusters, particularly in their ability to support SMEs and give birth to new start-ups through spin-outs. The objective of this report was to gather evidence that would confirm IAAPS has the ability to fulfill its potential in this regard. Even in the absence of detailed information about the IAAPS facility the report's findings suggest SMEs perceive they would use IAAPS for a number of quite broad reasons associated with access to information about the latest technologies, increasing their own profile and accessing industry contacts and government funding. SMEs involvement with IAAPS would be even more likely if IAAPS was closely involved with at least one large global OEM. While the sample size is statistically adequate, there is the caveat that any tentative conclusions drawn from the report are based upon a relatively low response rate (9.7%). IAAPS is evidently well regarded by the high R&D intensity firms who responded although across SMEs more broadly, interest is limited. Nevertheless, focusing on building strong relationships with high intensity R&D firms may be a more appropriate strategic approach to the nurturing of a regional cluster, rather than a large number of SMEs more generally.

Bresnahan et al. (2001) have shown that while the growth in the numbers of SMEs in a region is attractive to policy makers, this and other such benefits of dynamic clusters arise once the cluster has taken off. While these outcomes explain the rationale for encouraging the establishment of industrial clusters, these commonly cited benefits do not explain how new clusters emerge, or identify the characteristics that are common across new clusters being successfully born. Starting new clusters is risky and relies on traditional economic factors like firm-building capabilities, managerial skills, a substantial supply of skilled labour and connections to markets (op cit, p.835). These continue to be crucial as the cluster becomes well established, even though most studies of clusters and government supported policy initiatives will focus on the effects at the cluster level only. By studying the historical emergence of now successful clusters from around the world (USA, UK, Netherlands, Scandinavia, India and Taiwan) Bresnahan et al. (2001) identified several common characteristics in the clusters' emerging stage.

First, the new clusters all took advantage of new technological and market opportunities that had not yet been exploited. Established firms were either blind to, or unwilling and/or unable to move from their existing technological and market bases toward these areas of new opportunity. It may be some established SMEs surveyed regard IAAPS as a threat to their existing technological knowledge base and competencies (although this threat may not in fact be real) hence they are unwilling or unable to envisage the potential of working with IAAPS. It is only that minority of established firms, those with a degree of openness in their mind-set, who see the new opportunities and trajectories IAAPS could lead them to and who respond positively to the potential establishment of IAAPS. Additionally, new entrepreneurial firms (e.g. university spin-outs) may yet emerge to take advantage of IAAPS in future, but obviously these cannot be surveyed.

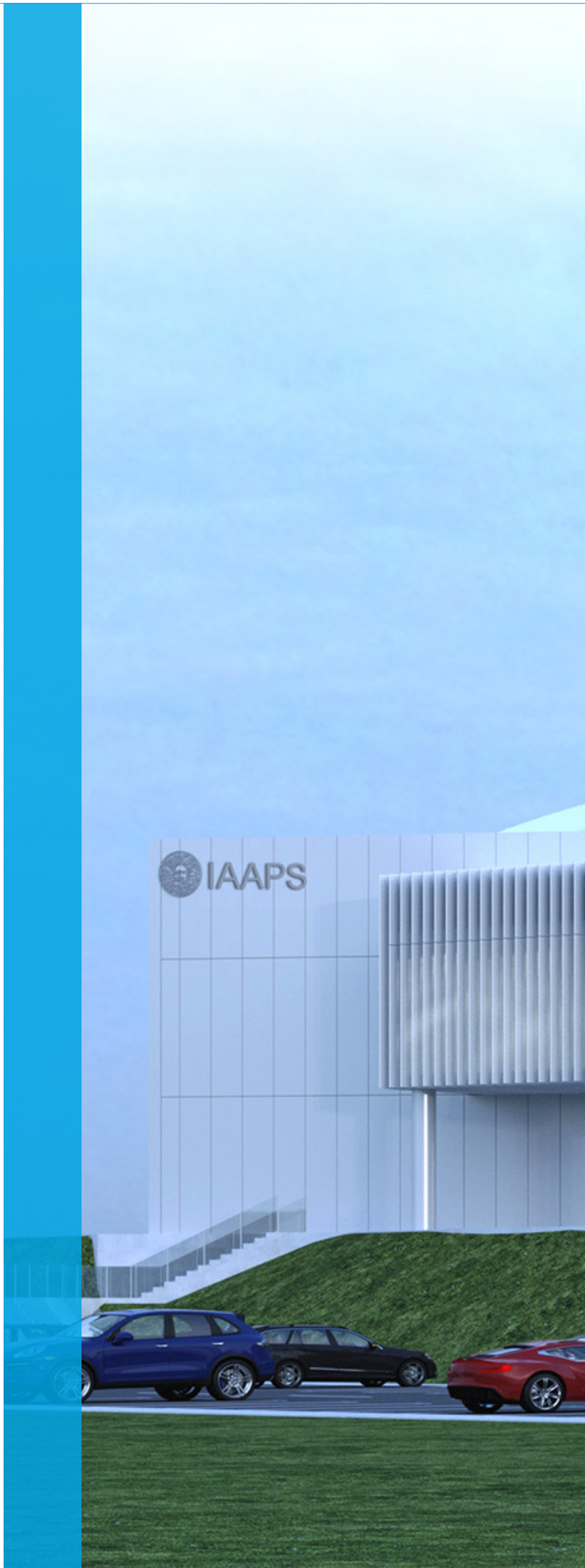
Secondly, Bresnahan et al. (2001) found all the technologies in the new clusters were complementary to existing technologies rather than direct challengers. Often they were in demand by established large corporations who were seeking to gain access to these technologies to extend their own industrial activity into new technological directions and prolong their corporate longevity. In other words, there was scale in the demand for the new technologies emerging in these successful new clusters. Yet in studies of industrial clusters, the role played by the traditional 'demand forces' is under-represented relative to the effects of agglomeration and externalities effects associated with knowledge sharing on the supply side. Critically for IAAPS, in seeking to establish a new cluster in low-carbon automotive propulsion, it should seek to establish where the demand for IAAPS technological output is going to be greatest and build strong links to key players in those regions. In other words, those automotive OEMs who have the greatest interest in low carbon automotive propulsion systems (either because of their predictions about the future regulatory environment, or customer demands for low carbon vehicles) must be linked to the nascent cluster at the earliest stage. Whilst the investment intent currently expressed by a US-based global OEM is a good start in this direction, IAAPS could seek to engage other European and Asian Car manufacturers for whom low-carbon propulsion technologies is high on their list of priorities and possibly, through collaborative efforts, help to establish industrial standards in this new area.

The third common feature in of the birth of now successful clusters was the plentiful supply of high skilled labour. This is obviously something the University of Bath's relationship with IAAPS can provide. However, it may be that the proposed postgraduate Masters and PhD student provision is insufficient to provide the number of employees that would attract new firms to the region. A cadre of undergraduates over many years may be required to support the cluster's growth, both by taking their knowledge and skills to existing OEMs, but also to generate some of the entrepreneurial organisations that could be born during the cluster's growth phase. This could be enhanced with joint provision of entrepreneurship studies from the School of Management. However, the university should not be the sole provider of skilled labour. Indeed a university presence in a cluster is 'neither a necessary nor a sufficient condition' for the cluster's establishment (Bresnahan et al. 2001, p.847). Firms should also provide training and nurture technological activity and the use of apprenticeship schemes is to be encouraged. It is also possible that skilled engineering labour and new firms in complementary technological areas can spin out of the South West's existing technological bases such as aerospace and ICT. There is some, albeit limited, evidence of this from the survey responses from aerospace firms. A final source of high skilled labour in successful new clusters is immigrant engineers although given the prominence of the immigration issue in the recent Brexit referendum this source may become harder to access in future.

Fourth, in now successful clusters, the human capital element had not only technical skills but also managerial skills. As mentioned above IAAPS would be well placed to offer training in this area should it seek to establish training links with the School of Management – a top UK management education provider. Managerial training can also be provided on the job e.g. for graduates from the

specialized engineering programmes, giving graduates confidence that they have both the technical and commercial skills required to establish a start-up later on. Mentoring from other entrepreneurs would also ensure the transfer of managerial knowledge and again the University of Bath is well set up in this regard with SetSquared being the global no. 1 university business incubator.

One of the key economic arguments in favour of industrial clusters and often cited as a key metric of a cluster's success is growth in the number of new firms established. However, Bresnahan et al. (2001) point out there is a difference between the growth in the number of new firms and the growth of firms themselves. Given that around 40% of new businesses fail in their first year and even up to 90% over 10 years (Timmons (1990), from Dimov and De Clercq (2006, p.207)) , the growth in the number of new firms in a cluster at any point in time can be a misleading indicator of the cluster's success. A better ambition and indicator would be the growth of a number of firms from the cluster that can claim a significant stake in future world markets e.g. emulating Sage and ARM Holdings, even if ultimately they are acquired by foreign multinationals (as ARM has been in its recent acquisition by SoftBank). This is a shortcoming of the UK manufacturing sector generally. Of course one cannot predict ex ante which firms are likely to become these future champions, thus while the potential growth in the number of new firms is used as an argument for UK government funding of IAAPS, in practice, it needs to be recognized that the business environment and mechanisms to encourage a small number of these start-ups to grow to international significance are also needed.



6. Conclusions and Recommendations

The University of Bath commissioned this research report in order to ascertain the extent to which IAAPS would be used by SMEs and act as a magnet for new firms to locate in the South West to support regional economic growth. While survey results do indicate some support for IAAPS, the strength of support appears to be less than anticipated at this stage due to SMEs requiring further information on IAAPS in order to determine the benefits it will bring. It is clear from the results the IAAPS project needs to engage more directly and more deeply with SMEs if it is to be seen as an inclusive project which will build networks, capabilities and exploit synergies with SMEs, thus enhancing the competitiveness of the UK automotive and related technology sectors. In part, the response from SMEs is due to the fact that the majority of surveyed firms were unaware of the concept of IAAPS and unsure as to how it might be of benefit to them. The two-sided leaflet which accompanied the survey provided some general information, but it remained unclear for many firms as to how they might utilise the facility and in particular, how IAAPS differed from existing centres such as the new automotive propulsion centre at Warwick.

In part the response may be due to the limitations of sampling. The response of existing SMEs to a facility that proposes to deliver research in completely novel technological areas presents some potential biases or difficulties. Most existing automotive SMEs work with the current carbon (intensive) based technologies. Some SMEs are focused on day-to-day survival and may not be forward looking; for some that are, the future technological path they perceive may be unrelated to low carbon propulsion systems. Because of the nature of knowledge, it is hard for firms to switch from operating within one technological domain to another. Hence, for many the potential value of IAAPS cannot be seen, or can be seen but is predicted to be unrealizable at the individual firm level. It is also the case that firms that are less R&D intensive are likely to be less forward looking, they focus on producing and selling products currently in demand. Given these represent approximately half the automotive SME sample, some of the responses to the IAAPS proposal are unsurprising. It is more likely the new firms from neighbouring technological domains which start to converge with low carbon and propulsion technologies and those born from university spin-outs will find IAAPS an attractive proposition. Obviously the report was unable to survey the potential entrepreneurial start-ups and university spin-outs but it did capture some positive reaction emerging from the survey of aerospace SMEs.

The work of Bresnahan et al. (2001) however highlights that perhaps IAAPS should not be too concerned at this stage about the lack of significant numbers of SMEs who might wish to use its proposed facilities. In the birth phase of a cluster, the underlying factors of success relate to firm-building capabilities, managerial skills, access to skilled labour and connections to markets. It is only once the cluster becomes established that the benefits of agglomeration economies, external effects and increasing social returns of networking arise.

Recommendation 1:
In the short-term, more information needs to be provided to offer a clearer picture of IAAPS to the public. This is partly a marketing exercise and we recommend the University commission a promotional video of the proposed facility, outlining its objectives, how it is clearly distinct from, but complementary to existing automotive propulsion centres to highlight its added value. Critically, the types of network links envisaged with small firms should be highlighted as well as linkages to the more obvious corporations. In this regard, a networking event might be held at the University of Bath in early autumn 2016 to showcase the Powertrain & Vehicle Research Centre's facilities which the IAAPS proposal has grown out of and to give a visual representation to SMEs about the types of equipment and test facilities they could access at the IAAPS. Those high R&D intensity SMEs within the survey who indicated they would be interested in utilizing and working with IAAPS should be invited to meet key IAAPS stakeholders at this event to begin the knowledge and business networking opportunities.

Recommendation 2:
The IAAPS project should commit to supporting an onsite knowledge transfer team to help establish and strengthen existing local and international market connections. Whilst this should be a generally available service to all partners and clients of the IAAPS, it should incorporate a sub-team dedicated to nurturing and building a technology focused SME network and facilitate SME engagement in IAAPS related projects. This would support the firm-building capabilities identified by Bresnahan et al. (2001). We recommend this pledge be made within the actual IAAPS bid, so as to demonstrate the bid's clear commitment to utilising and enhancing UK SME capabilities and competitiveness.

Recommendation 3:
In the short to medium term, supporting a knowledge transfer team will incur a sunk cost. In building an SME network, the team may run events and propose a membership scheme, with an accompanying regular newsletter. Such events will probably have to be cross-subsidised either by the university itself, or from contracts with corporate users, since it is unlikely, at least in the short-term, that SMEs will be prepared to pay a fee for joining such a 'club'. As IAAPS's reputation grows and its facilities are increasingly utilised, it may be possible to charge 'members' a baseline annual fee, which entitles them to member benefits and a possible reduction in IAAPS 'user services'. Pricing here could be discriminatory, based on firm size, with possible incentives/reductions for (new) young firms.

Recommendation 4:

The governance structure of IAAPS and its relationship to the University of Bath is still under discussion. Nevertheless, the University can provide IAAPS with the two remaining factors identified as common across successfully established clusters: a pool of skilled labour and managerial capabilities. The current IAAPS proposition comments on providing a number of Masters and PhD graduates but the numbers are a relatively small contribution to the wider workforce. Establishing an undergraduate programme, or enlarging the proposed size of the Master's programme may help develop the pool of labour available to work in IAAPS or the companies within its future network. It is important that the availability of specialized labour meets the demand for such labour as the commercial opportunities associated with this novel technological area grow. Additionally, we suggest that measures to develop managerial capabilities are integrated into the degree programmes the university offers in the fields that will feed into IAAPS and its users. This can be done both through formal curriculum provision and within any industrial experience activity so that students experience not just the technical aspects of engineering, but also the business and commercial aspects that will enable students to generate commercial awareness about the business context within which the engineering firm is situated.

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