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Exploring the Feasibility of Anchoring Innovation by Enhancing the Linkage Between Manufacturing Research Networks and Supply Chains

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Abstract

In recent years the progressive investment in large translational manufacturing research facilities in the UK has exceeded all expectations for industrial involvement and uptake, and has resulted in a model which has influenced others at a global level. One of the reasons for the success of this substantial programme is that much of the strategy has been driven from markets and large OEMs down into day-to-day manufacturing operations. This has the huge advantage that manufacturing developments are catalysed from more general trends in the provision of next generation products, making large scale coordinated activity on technological innovation much more feasible than it would otherwise be. It is however still clear that its impact in the deep supply base is less than might be hoped. This can be seen as an indirect consequence of the top down approach. It raises a key question of whether an investment programme in manufacturing research and innovation alone is sufficient to anchor innovation in the country or region of origin. This paper explores the viability of more complete consideration of supply chains in securing maximum value for money from ongoing investment in manufacturing R&D and innovation.

Keywords: Translational Research; Innovation; Supply Chains; Manufacturing

1. Introduction

It is now well recognised that a translational step is needed between traditional university research and the industrial environment in order to secure a time-bound route to implementation. Technology Readiness Levels (TRLs) (Mankins, 1995) are often used to illustrate the need for planned stages of work between proof of concept and initial adoption in the factory environment. In these cases the so called 'valley of death' (House of Commons, 2013) or 'missing middle' (Wang et al., 2015) both coincide with intermediate TRL stages and relate to scale-up of the technology from laboratory to industrial implementation. In the UK the government has established the High Value Manufacturing Catapult (HVMC), a network of manufacturing innovation centres brought together with the objective of addressing the 'valley of death' between traditional academic research and industrial needs across a broad spectrum of manufacturing process technology.

A more considered view of the challenge indicates that, for commercialisation of research and innovation to achieve genuine transformational impact across a broad industrial spectrum, the operational as well as the technical complexities need to be addressed. In very simple terms, the provision of excellent technological innovation programmes is a necessary but not sufficient condition for transformational change in manufacturing. A more complete approach requires a degree of planning and support to address wider conditions, which are essential to ensure that innovations are properly converted into transformational economic impact. This broader challenge has been termed the 'long valley of death' (Ward et al., 2018) in which product, technology and supply chain are all considered as equally important dimensions in enabling ultimate exploitation. The HVMC has been established based on excellent linkages into major OEMs and with a strategy, which is highly aligned to national challenges at the sectoral level. On this basis the HVMC model, by design, can be seen to address the product and technology dimensions of the long valley of death quite effectively. The mechanism for progressing the supply chain dimension is less apparent. This paper explores some of the considerations that need to be made in progressing the supply chain dimension. It also presents an approach to systematising market sector level challenges with a view to directing more tailored approaches which address supply chain dependencies associated with manufacturing innovation.

1.1. Anchoring Innovation

The term Anchoring Innovation has been used in a classical context to explore the extent to which "successful innovations must somehow be 'anchored' for the relevant social group(s)" (Sluiter, 2016). In the context of manufacturing innovations and translational research the term has been used in HVMC over these past two years to describe a broad underlying challenge of ensuring that manufacturing innovations developed through HVMC

are implemented as broadly as possible in the UK supply base. The concept therefore relates to the definition of a common set of active steps needed to ensure that developed innovations result in sustained economic growth and prosperity in the country of origin. Several of the key ingredients for anchoring innovation clearly must reside with partner companies and other stakeholder groups who are the end users of developed manufacturing technology. The question remains however whether it is viable to define a generalised approach or framework that can help to categorise and position candidate areas of industrial challenge to help better direct the approach to the translational research and increase the likelihood of successfully anchoring innovation. This question of the viability of a meaningful framework approach to anchoring innovation has formed the basis of the work that is summarised in this paper, especially in the context of larger and more complex publicly funded programmes.

1.2. Background

Work to develop the anchoring innovation concept was launched following a series of more narrowly focused supply chain initiatives, originating from work done in relation to the UK metals sector. Over that period it became clear that a broader and more holistic approach was desirable as a means of driving full recognition of the need to establish a viable UK-wide basis for technology enabled manufacturing transformation. The sequence of events which led to focused work on the anchoring innovation question is shown in Figure 1. As the figure suggests, three key elements of anchoring innovation where identified through initial dialogue with a number of public sector, academic and industrial stakeholders. The methodology followed in the remainder of the project was based on further dialogue and case study evaluation based on these three elements:

1. Evidence. Review and evaluation of large-scale national challenges with the aim of generating evidence of a generic planning gap in the area of anchoring innovation.
2. Visibility. Identification, evaluation and clarification of current and emerging barriers to embedding innovations for UK value creation based on specific case studies.
3. Strategy. Use of the same case studies to investigate whether common strategic issues emerged in the attempt to develop holistically planned programmes centred on investment in technology.

The project involved articulating the problem associated with the current arms-length relationship between innovation programmes and the supply chain. This comprised a combination of evidence gathering around specific examples in the discrete manufacturing supply base, collation of some best practice supply chain mapping examples, and definition of some of the elements of a framework for Anchoring Innovation.

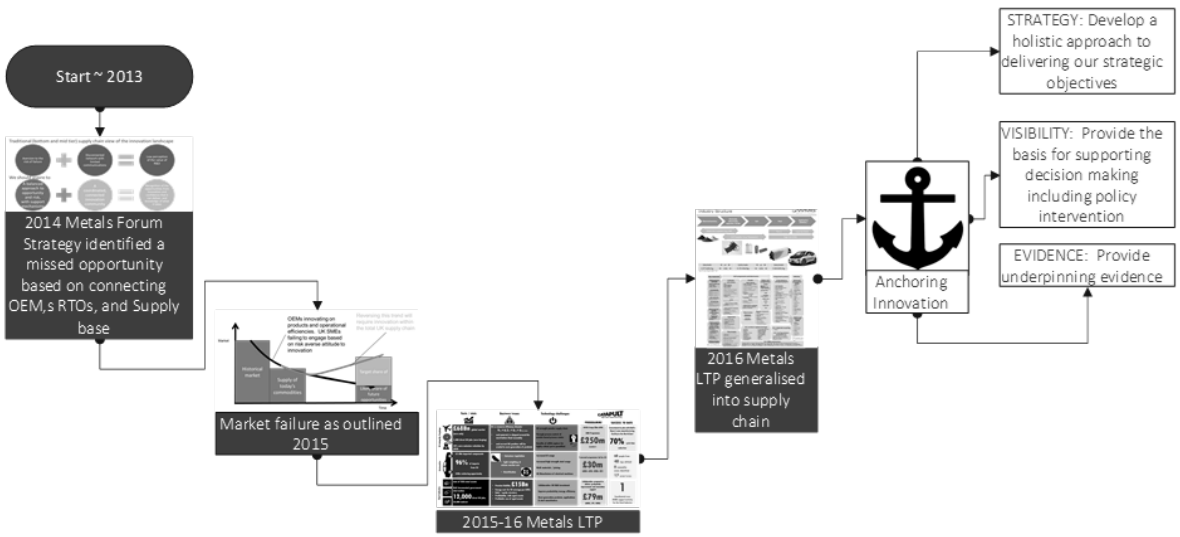


Figure 1. Outline of the background to Anchoring Innovation.

2. Concept development

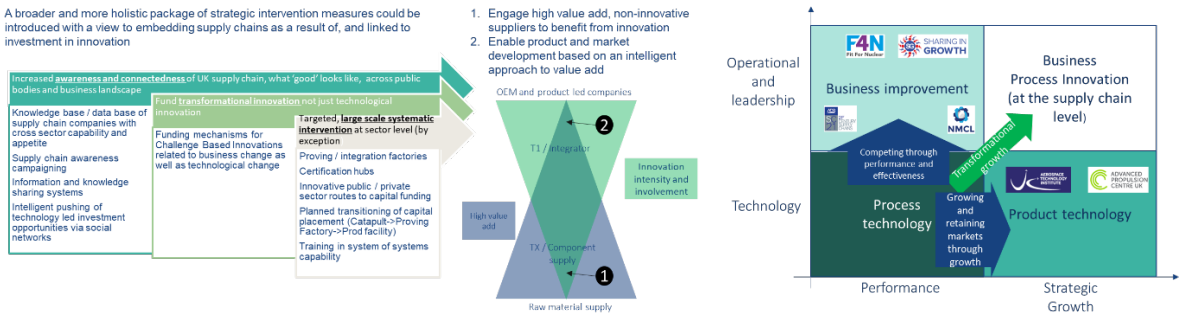
Exploration of the feasibility of devising a structured framework for anchoring innovation has been aimed at assessing the opportunities from, and feasibility of a common set of tools aimed at:

- Driving value for money from investment in innovation
- Targeting investment
- Delivering impact
- Addressing productivity at supply chain and national level, not just the single company production level.

The work has developed based on the premise that it is essential that the HVM Catapult, as a technology innovation organisation, gives its programmes the best possible chance of full and successful implementation in the country

of origin. This has a greatly enhanced probability of success based on proper understanding the status of supply chains related to the areas of technological development and present in the host country. An approach to potential intervention and a four-box model which shows how the role of the HVMC has progressively transitioned into supply chain relevant areas is shown in Figure 2.

Stakeholder discussions based around this initial thinking highlighted concerns about why any form of public intervention would be deemed necessary or appropriate to address the supply chain specifics. The arguments set out in Figure 3 were developed in response and seek to illustrate why technology interventions alone are insufficient to drive change, and why the issues are unlikely to be address based on markets and individual companies. This viewpoint led to the extension of the four-box extension model of the HVMC role being extended into a nine-box model which deals with collaboration beyond the single company level, as shown in Figure 4(a). That nine-box model has formed the basis of much of the subsequent thinking. Some minor changes in wording and description have now been applied to provide the Systematised Model for Anchoring Innovation (SMAI) shown in Figure 4(b).



(a) Early Stage view of potential intervention mechanisms

(b) Development of HVM Catapult and other UK initiatives which extend into the company level supply chain improvement space

Figure 2. Initial view of intervention mechanisms.

(a) Why technological innovation alone is not enough

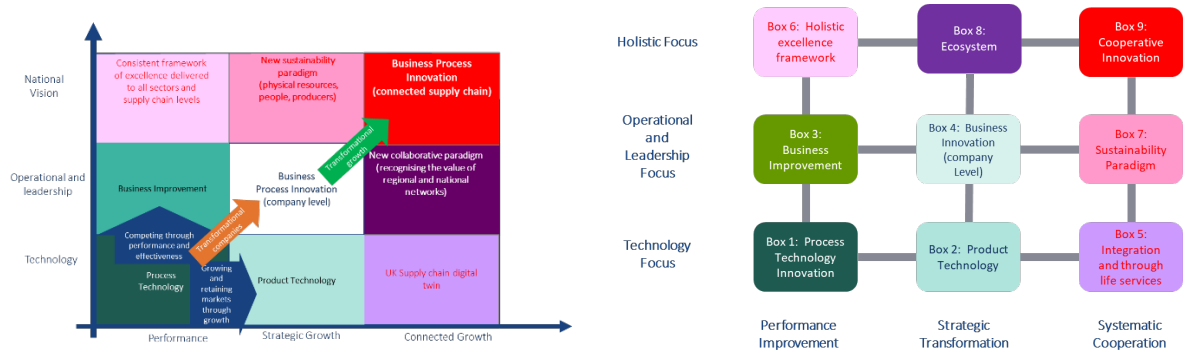
(b) Why the market alone does not address the issue

Figure 3. The case for intervention and the innovation conundrum.

The SMAI, as shown in Figure 4(b), provides a basic approach to systematically defining suitable forms of intervention which can be linked to key national sector challenges and technology opportunities. The value of this model lies in the view that challenges and opportunities of different types can be expected to exist in each of the nine boxes, as follows:

- *BOX 1: Technology Innovation*. Typical challenges would either relate to a gap in current manufacturing technology versus market needs, or an under exploited technology opportunity. Likely interventions would either be based around process technology development, or an adoption strategy.
- *BOX 2: Product Technology*. Typical challenges here would relate to getting a new generation of product to market, based on the right level of functionality therefore technology, in time to capture the market. Interventions here would be specific support to a product programme or sector challenge.

- *BOX 3: Business Improvement*. Challenges in this category relate to suboptimal business performance within the supply base. Interventions would include diagnostics and business improvement support services.
- *BOX 4: Business Innovation* (company level). Challenges in this case would be related to the organisation of supply and demand and the establishment of the best available ways of doing business. Interventions here would be in the form of provision of consultancy services.
- *BOX 5: Integration and through life services*. Typical challenges for through life service integration extend beyond getting a new generation of product to market, and to a broader system-based offering. Interventions here would be specific support to or sector challenge or opportunities.
- *BOX 6: Holistic excellence framework*. This relates to situations where there is a need to bring together operational excellence frameworks with best in class technology implementation. A successful Anchoring Innovation programme could result in provision of a set of innovations in this area.
- *BOX 7: Sustainability paradigm*. Here the challenges relate to the sustainment of those companies, and perhaps clusters of companies, which are already operating with world class business processes. The pace of change in business offerings and global competition might represent a threat in this category. Interventions here would be specific packages of measures relating to the highest performing and highest potential organisations and clusters of linked companies.
- *BOX 8: Ecosystem*. This box relates to situations where a gap in supply can only be addressed by a number of companies working together, as even the biggest organisations have insufficient scale or interest to address the challenge alone. Interventions here would include stimulation at an entire region or sector level with a view to creating innovation districts.
- *BOX 9: Cooperative Innovation*. This seems to be the ultimate target area in the model and would relate to genuine and natural cooperation between very high performing organisations. Interventions would described for the other nine boxes of the model would help progress towards this end point but, more critically, identification of those industrial challenges which require performance at this level, and where such performance is feasible, will be an important success factor in ensuring the right approach is taken to selection of strategic objectives into the future.



(a) Initial attempt to systematise the broader needs in linking innovation and supply chain

(b) Systematised model for anchoring innovation

Figure 4. Anchoring Innovation model for systematic and cooperative process innovation.

The central theme of the SMAI is to drive consideration of increased and enhanced collaboration and cooperation, beyond single organisations. This is consistent with work in the area of research policy (Weber, 2012) which outlines the need to extend transformational interventions beyond market failures and into more systematic issues in driving large scale change from innovation. Some of the typical issues, which need to be addressed under the category of 'system failures' are superimposed on the nine box model in Figure 5.

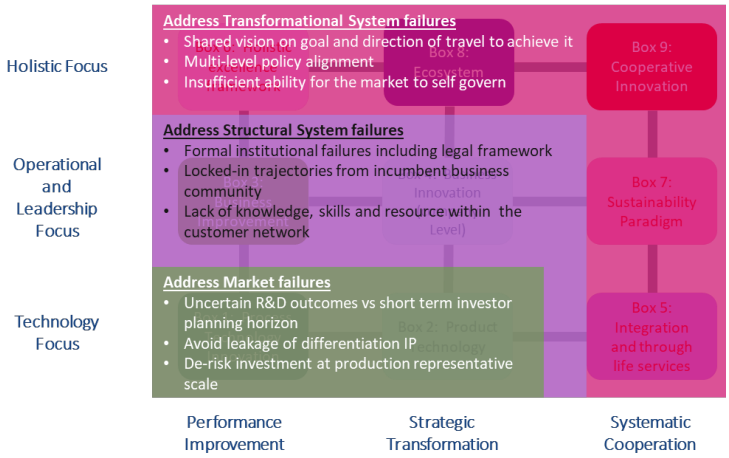


Figure 5. The SMAI and the extension to system-based issues.

3. Testing the framework and defining a strategic framework

The SMAI framework was used as part of an evaluation of the HVMC strategic plan in the latter part of 2018. The plan is based on a number of strategic objectives. These objectives are broadly split between major sectoral challenges relating to manufacturing at the UK national level, and key areas of potential disruption through emerging manufacturing technology. Commercial sensitivities prevent a full summary and description of the specific outcome of that evaluation, however Figure 6 has been developed to illustrate how each of these quite different areas of national challenge and opportunity can be mapped onto the SMAI, illustrating the potential to tailor approaches to intervention at the level of large integrated programmes.

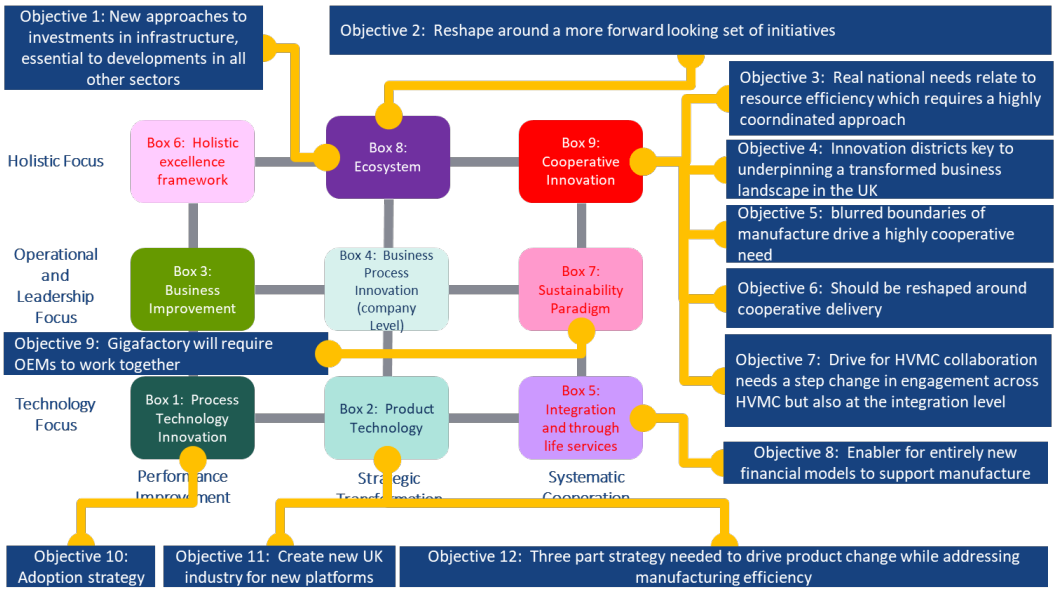


Figure 6. Testing the SMAI against major strategic objectives.

The assessment process has demonstrated the viability of a structured approach to linking supply chain and technological innovation, and of using such an approach to direct focused interventions. A further step is needed to establish benefit from such an approach. An outline illustration of a potential strategic approach which would be applicable to the UK, based on the backdrop of the HVMC with its strengths and challenges is shown in Figure 7. The key enabler to such a strategy would be the intent to make the consideration of anchoring innovation a routine aspect of planning at the strategic and tactical level.

The assessment process which was undertaken on each of the HVMC strategic objectives also made it clear that consideration of workforce needs to be considered alongside, or as a subset of, supply chain. Extending the consideration to include consideration of workforce is also consistent with approaches that are developed internationally (Executive Office of the President of the United States, 2018), where dimensions of technology, supply chain and workforce are employed.

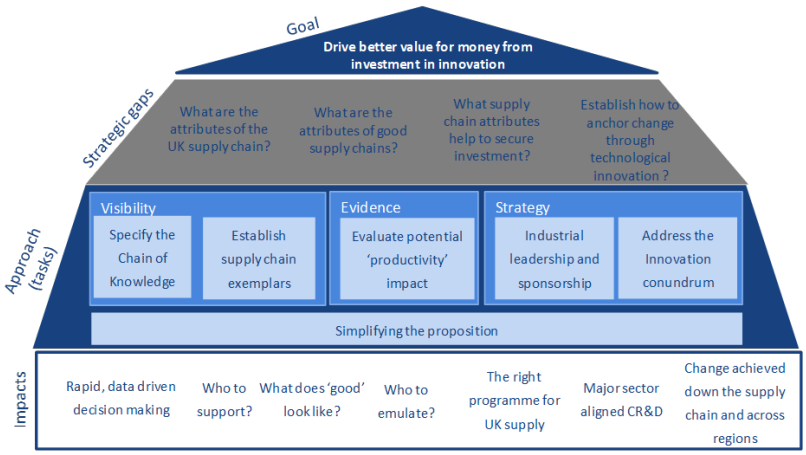


Figure 7. Gaps, issues and approaches in addressing the drive towards improved value

4. Conclusions

At any given time there will be known and emerging barriers to embedding innovations for value creation, in local supply chains, these need to be overcome or navigated in order to deliver our strategic objectives. The specific nature of the UK manufacturing research landscape, which incorporates the HVMC, means that technology and product dimensions of maturity are effectively 'designed in' to the national infrastructure. Additional efforts are needed with respect to supply chains. Similarly, commercialisation of research and innovation requires an additional level of planning and support, to address wider considerations, beyond the delivery of excellent technology programmes. Establishing better value for money from the large investment in manufacturing innovation through translational research networks is challenging, but the potential to direct approaches based on a systematic assessment of the particular sector and objective under consideration is viable. The SMAI forms the basis of such a framework and appears promising in its ability to distinguish between different situations and direct different types of corrective intervention. The valley of death and long valley of death approaches are both used as mechanisms to describe the declared market failure associated with research translation. The wider consideration of supply chains indicates the existence of somewhat deeper system failures and the structural and transformational level which require different corrective action. The SMAI is useful in distinguishing between market, structural system, and transformational system failures. The success of any approach to anchoring innovation is based on the ability to establish it as a 'business as usual' approach within industrial strategy and the allocation of funds. Workforce development is a key element of the supply chain dimension.

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