

Parks and innovation

Lessons from Sheffield's Advanced Manufacturing Park

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May 2019



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Acknowledgements

We wish to thank Ruth Arnold of the University of Sheffield and Hugo Bessis for their contribution to this report.

We also wish to thank Harworth Group plc for providing the images of Advanced Manufacturing Park featured in the report.

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Executive summary

Sheffield's Advanced Manufacturing Park (AMP), which contains the core of the University of Sheffield Advanced Manufacturing Research Centre (AMRC), is helping transform Sheffield City Region's economy from a place for low-cost production to a place for high-value knowledge production.

The AMRC is a research institution based on the AMP that links researchers and academics with firms in the advanced manufacturing sector around the UK and the rest of the world. Large multinationals such as Boeing, BAE Systems, McLaren, and smaller supply chain firms have operations on the site or tap into the research that takes place there.

This report explores the impact of policies on the AMP and the way they increase highly-productive and skilled manufacturing activity in the local economy of Sheffield City Region. It also sets out lessons for other cities and policymakers. Its main findings are:

The AMP has a concentration of highly-productive exporting work. The AMP accounts for 499 advanced manufacturing jobs. Although its contribution of jobs to Sheffield City Region is modest, these jobs are more productive than manufacturing in the rest of the Sheffield City Region, and show how the park has been able to attract higher-skilled activities.

The AMP is attractive to advanced manufacturing firms because it is a hub of knowledge and applied research expertise. Access to engineering graduates and postgraduates from the University of Sheffield, its open-source research model that shares discoveries across the AMRC's network without patents, and face-to-face interactions with other skilled firms and researchers working on the AMP are critical to the AMRC's success. This creates links with production centres across the country and around the world and makes the AMP nationally significant.

The AMP highlights the importance of place as the integrator of the other four pillars of the Government's Industrial Strategy. The AMP is a concentration of knowledge-intensive exporting activity. It is a location where research is created by high-skilled individuals and firms, which is then applied to production processes elsewhere. By bringing together this activity in a place, it supports people and ideas in Sheffield City Region and increases the productivity of economic activity elsewhere.

The AMP and AMRC provide important lessons for the Government and for other places developing advanced industrial parks of their own:

Access to knowledge drives economic differences across places. As a whole, the Sheffield City Region underperforms in its provision of skills. Accordingly, less-skilled and lower-paid work characterises the city region's economy, while work that requires many skilled workers locates elsewhere. However, due to the matching of skilled workers from the University of Sheffield with firms on the AMP and the research that takes place on the site, the AMP is able to appeal to new and higher-paid activity.

Activities in one place often have benefits in other places. The AMP's role as a place of innovation and high-skilled activity means that some of the direct economic benefits of the AMP, such as new machining techniques, are realised in other parts of the country where low-cost manufacturing takes place. The relevance of the AMP to National Industrial Strategy is, therefore, how it improves the performance of firms across the country, and not just in Sheffield City Region.

The open-source approach to research has enabled the AMRC's success. Advanced manufacturing sites already in development, such as in Sunderland, Tees Valley, and Glasgow, that are looking to repeat the success of the AMP will need to share its key advantages. This includes not just access to skilled workers, but links with a university, the open-source innovation model without patents, and a network of firms with activity outside the new site that can benefit from research that takes place there.

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Introduction

Our most successful cities today are those that have adapted to the transformation of the national and the global economy over the last century. Their traditional industries have declined due to processes such as containerisation and globalisation, and they have reinvented their economies around knowledge rather than physical advantages such as access to coal, iron ore, or waterways.¹ These cities have attracted investment from high-skilled exporting businesses that create new innovations, boost local wages, and drive the local economy.

This means that to support the ability of places to adapt, the long-term strategic objective of economic development policy should be to improve the stock, flow, and use of knowledge in local economies, by improving the benefits cities offer to higher-skilled exporting activity in both services and manufacturing.

Due to its success in attracting higher-skilled exporting activity, the Advanced Manufacturing Park (AMP) located in Rotherham, and the University of Sheffield's Advanced Manufacturing Research Centre (AMRC) located on the park, have received significant interest from policymakers.²

This report looks at how the interventions made by the University of Sheffield's AMRC have ensured that the AMP is an attractive place to invest, including through national and international partnerships with global industries and their supply chains. It also draws out lessons and experiences from the AMP for Local Enterprise Partnerships and local and national policymakers, as they consider how to use their Local Industrial Strategies to make themselves more attractive places for investment from high-skilled, exporting companies.

Section Two sets out the context of Sheffield City Region's economy in which the intervention is taking place. Section Three identifies the quantitative impact of the AMP and AMRC on Sheffield City Region's economy and compares it to similar parks. Section Four explores the nature of the AMP and the interventions made, and their implications for local and national industrial strategies. Section Five summarises the conclusions and provides recommendations for policymakers.

1 Swinney P and Thomas E, "A Century of Cities - Urban Economic Change since 1911," 2015

2 HM Government, "Industrial Strategy: Building a Britain Fit for the Future," 2017

The research uses quantitative evidence to look at economic activity at both the city-regional and the very local level of the AMP and similar parks, and qualitative evidence from interviews with firms involved with the AMRC.



R-Evolution Unit in Sheffield's Advanced Manufacturing Park

Source: Harworth Group plc

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The role of manufacturing in Sheffield City Region's economy

Sheffield City Region is one of the largest city-regions in England, but in the decades following the decline of steel and coal production, its economy has performed poorly as it has struggled to adapt to economic change.³ The foundations of the city-region's urbanisation were its exporting strengths in manufacturing. In 1911, there were 182,000 manufacturing jobs across Sheffield City Region, which constituted 43 per cent of all employment.

But the city-region's economic performance declined due to deindustrialisation over the second half of the 20th century, in common with many other cities.⁴ Although manufacturing's share of local employment was still 43 per cent in 1971, this shrank to 11 per cent in 2011 (63,000 jobs).

While other cities like Leeds and Reading have been able to transition their economies from manufacturing to higher-skilled and more knowledge-intensive activity, Sheffield City Region has struggled to do this and has largely replicated an existing structure of low-paid and low-skilled work. As a result, the average wage in the city-region is low at £459 a week, compared to a national average of £539. Sheffield City Region's wages are also lower than in other core cities such as Leeds and Manchester, where weekly wages are £540 and £526 respectively.

Why Sheffield City Region's overall economy does not perform as well as other large cities

Exporting firms are key to local economic performance. These firms sell to markets mostly outside their location, whether to other cities, regions, or abroad. This includes everything from car assembly and forging steel, to high-skilled services like architecture and technology. They stand in contrast to local services such as dry cleaners, solicitors, and restaurants, which sell mostly to their local market. These local service firms have similar levels of productivity across the country and therefore cannot explain geographic differences in economic outcomes between cities. Local services need to locate in areas where there are lots of customers with money to spend, usually cities. In contrast, as exporters' markets are always elsewhere they can choose to locate in the cities that suit

3 The definition of Sheffield City Region used is the Sheffield City Region Combined Authority, led by the Metro Mayor. This was chosen over the Sheffield PUA or the wider definition including parts of Derbyshire due to Sheffield City Region's role in leading on the Local Industrial Strategy

4 Swinney P and Thomas E, "A Century of Cities - Urban Economic Change since 1911", 2015

their unique needs. This explains why cities' economic performance varies so much – cities offer different benefits that can meet the distinct needs of high- and low-skilled exporting firms, which then shapes the performance of local services.

For high-skilled exporting firms, the crucial resource a place must possess is knowledge. Firms in areas like software development, financial services, and engineering locate their highest-paid work where they can find skilled workers to take on the specialised roles their activity requires.

For low-skilled exporting activity such as logistics or assembly plants that do not need such specialised workers, the priorities are instead keeping the costs of land and labour as low as possible. This means firms locate in places where land is cheap and wages are low. As a result, they struggle to pay high wages or sustain demand for local services.

A city's ability to generate knowledge is therefore decisive in terms of achieving high productivity and wages in an urban economy. Cities with weak skills profiles struggle to appeal to higher-paid exporting firms.

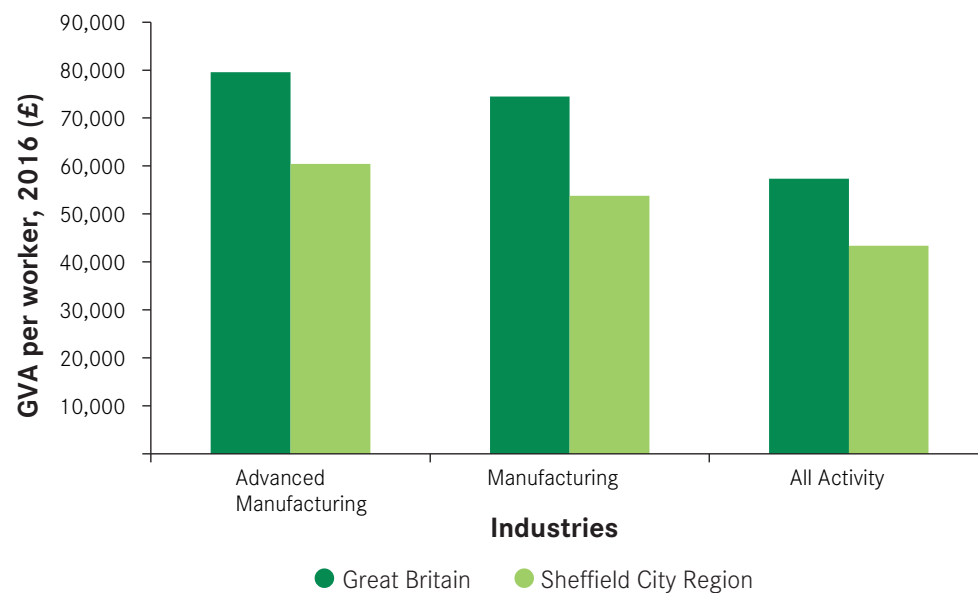
This explains the economic performance of Sheffield City Region. In the average UK city, 49 per cent of exporting firms are high skilled, but in Sheffield City Region it is only 20 per cent. This is also reflected in the skills of manufacturing workers – Figure 1 shows that only 18 per cent of workers in manufacturing in Sheffield City Region have degrees, compared to 24 per cent in England and Wales as a whole, and, for example, 46 per cent in Crawley, which has the highest share of any city in England and Wales.

Figure 1: Share of Workforce with degree level qualifications



Source: Census 2011

The skills deficit means Sheffield City Region tends to appeal to exporting businesses as a place of lower-cost and lower-paid production. As a result, Sheffield City Region's economy has lower productivity compared to the rest of the country. Figure 2 shows that productivity is lower across all activities in the Sheffield City Region, including manufacturing and advanced manufacturing, than the national average.

Figure 2: Gross value added in manufacturing per worker, 2016 (£)

Source: ONS, Nominal and real regional gross value added (balanced) by industry, Business Structures Database, 2017

Box 1: What is advanced manufacturing?

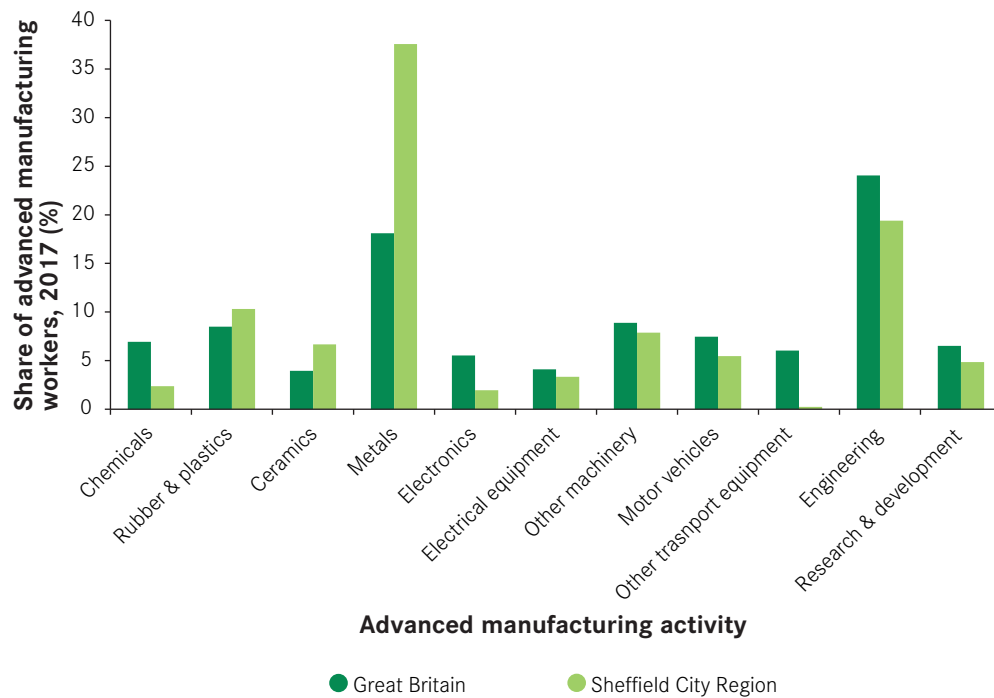
Manufacturing plays an important role in the economy of many British cities, both in terms of jobs and trade with other cities, regions, and countries.

Most knowledge-intensive manufacturing is referred to as ‘advanced manufacturing’. This activity requires high-skilled workers, small and often experimental production runs, and the use of information technology to monitor the production process. It is closely related to engineering and is a key part of “Industry 4.0”.

This report uses a narrower version of an OECD/ONS definition of medium-high tech manufacturing to create an index of advanced manufacturing, for which the full lookup is in the appendix.

The advanced manufacturing in the Sheffield City Region tends to be lower-skilled than that found in other cities. Looking at the different types of activity that can be grouped under advanced manufacturing, Figure 3 shows that Sheffield City Region has a particular concentration in metal fabrication, and a lower than average representation in most other fields. The highest-skilled areas in advanced manufacturing like engineering and research and development are the second largest share of advanced manufacturing activity, but still a smaller share than the national average.

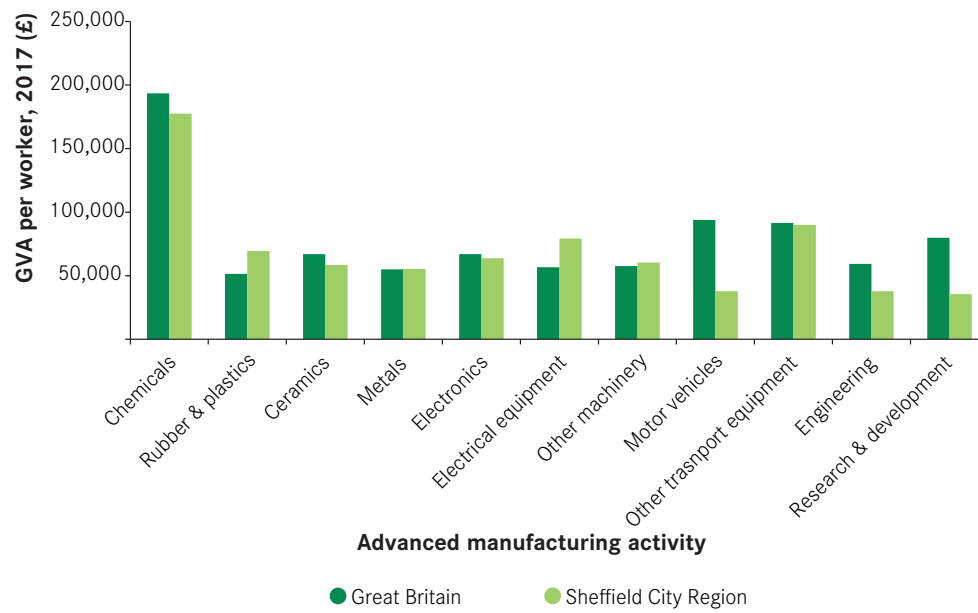
Figure 3: Share of workers across different types of advanced manufacturing and engineering activity



Source: ONS, Business Register and Employment Survey, 2012

Not only are advanced manufacturing and engineering workers in Sheffield City Region as a whole over-represented in low productivity fields, many of these fields perform at a lower level of productivity than the national average. Figure 4 shows that engineering and scientific research face a large productivity gap in the Sheffield City Region, with engineering only 64 per cent as productive as it is in the rest of the country, and private R&D being only 44 per cent as productive as the national average. These are fields that are particularly important for providing high-skilled advanced manufacturing work. Across the city-region they currently underperform compared to other places.

Figure 4: GVA per worker across different types of advanced manufacturing and engineering activity



Source: ONS, Nominal and real regional gross value added (balanced) by industry, Business Structures Database, 2017

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The performance of the AMP in Sheffield City Region and beyond

Addressing Sheffield City Region's productivity problems, therefore, means not just improving the productivity of existing activity in Sheffield, but also ensuring that new and higher-skilled exporting work is created in and attracted to the city-region.

The University of Sheffield's Advanced Manufacturing Research Centre (AMRC) and the Advanced Manufacturing Park (AMP) in which the core of the AMRC is based is part of the response to this issue.

Box 2: What are the AMP and AMRC?

The University of Sheffield's AMRC and the AMP are distinct. The AMRC is a University-owned industrial research institution that links together advanced manufacturing research expertise in the University of Sheffield with multinational supply-chain manufacturing companies both in Sheffield and outside it.

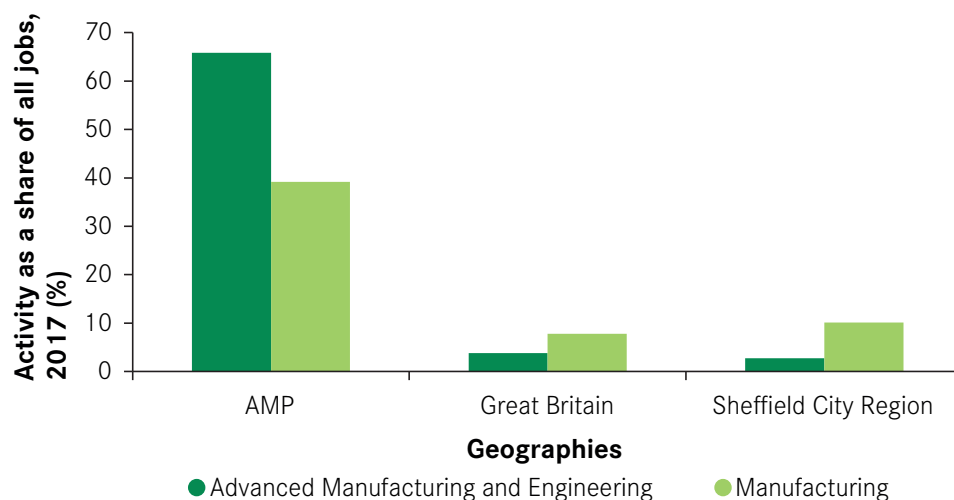
The AMRC is a Catapult facility with projects across a range of areas including aerospace, automotive, civil nuclear energy, and health and is primarily located on the AMP. The AMP is located in Rotherham, close to the boundary with Sheffield.

The AMRC provides small amounts of commercial space for companies and manufacturing and access to industry-leading research equipment for experimental production runs. Companies that decide they want a more involved relationship to the AMRC's benefits can locate on the AMP in facilities of their own, or they can remain elsewhere and tap into the wider network when they wish.

The AMRC includes specialist spaces such as the Nuclear AMRC, the Medical AMRC, and Factory 2050, with industry collaboration based in Sheffield. The AMRC is part of a network with activities elsewhere in the country, including at the Airbus wing-manufacturing facility in Wales.

In contrast to the Sheffield City Region as a whole, the AMP is a cluster of advanced manufacturing jobs. Figure 5 shows that 66 per cent of all jobs in the park are in advanced manufacturing. This is compared to 4 per cent in the UK as a whole, and 3 per cent across the Sheffield City Region.

Figure 5: Advanced manufacturing and engineering, and manufacturing as a share of all jobs⁵



Source: ONS, Business Structures Database, 2017

As Figure 2 shows, this advanced manufacturing is especially productive work compared to the rest of Sheffield City Region's economy.

The AMP also outperforms in its appeal to advanced manufacturing and engineering compared to other similar parks around the country. Figure 6 shows that the AMP has the highest share of advanced manufacturing jobs compared to similar industrial estates in other parts of the country.

⁵ The definition of advanced manufacturing used in this report includes engineering and scientific research activities, while manufacturing in this graph refers exclusively to manufacturing activity, both advanced and non-advanced. This graph is looking at advanced manufacturing and engineering as well as manufacturing as a share of all jobs within each geography.

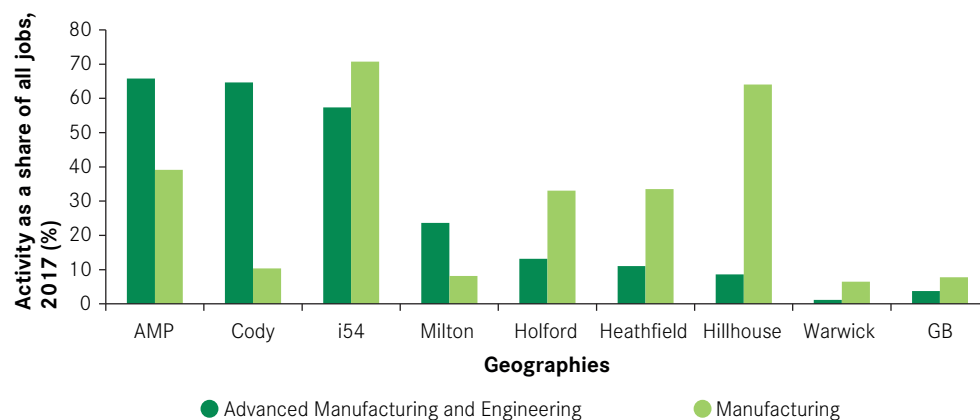
Box 3: Comparing the AMP to other parks

A number of similar initiatives such as the International Advanced Manufacturing Park in Sunderland; the Advanced Manufacturing Innovation District Scotland in Glasgow; and the Teesside Advanced Manufacturing Park are not yet in operation and therefore cannot be evaluated.

To compare the performance of the AMP to other places, a number of employment sites similar to the AMP were identified that were small enough to be distinct areas of advanced economic activity but large enough not to be dominated by one single manufacturing employer.

These include i54 in Wolverhampton/South Staffordshire, Cody Technology Park in Aldershot, Milton Park in Oxfordshire, Holford in Birmingham, Hillhouse near Blackpool, which is part of Lancashire Energy Enterprise Zone, Heathfield Industrial Estate in Exeter, and Warwick Technology Park.

Figure 6: Advanced Manufacturing and Manufacturing as a share of all local jobs



Source: Business Structures Database, 2017

Despite being associated with advanced manufacturing or manufacturing parks, several of the parks do not seem to be particular concentrations of either activity. Milton Park in Oxfordshire has a small share of advanced manufacturing. Warwick Technology Park has very few advanced manufacturing or manufacturing jobs as a share of total employment – and has a much greater share of jobs in programming, consulting, or head office activities.

In terms of advanced manufacturing, Cody Technology Park in Aldershot is the most similar to the AMP – it has a strong aerospace and defence presence, but unlike the AMP, little on-site manufacturing.

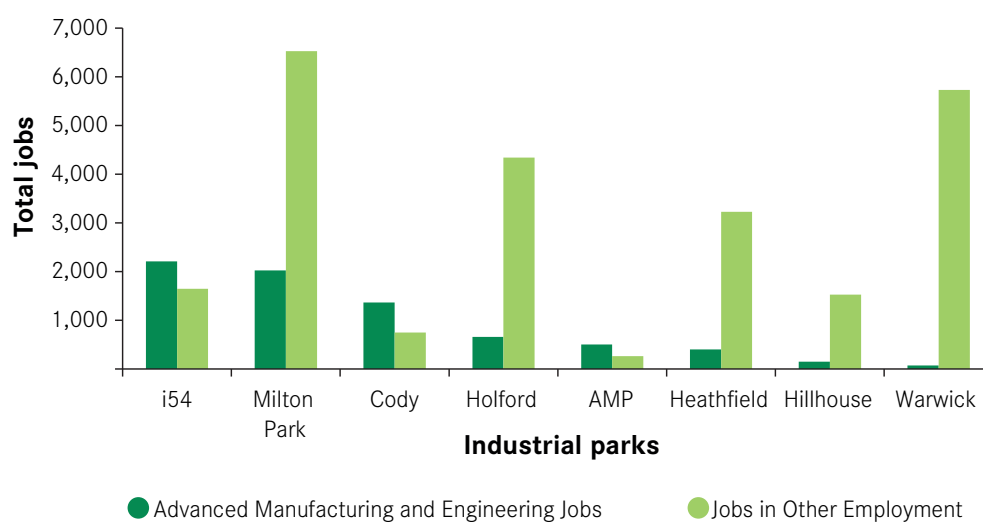
The AMP is a small part of Sheffield City Region's economy

In terms of employment, the impact on Sheffield City Region's economy is modest. Only 499 private sector advanced manufacturing jobs are on the site, a small share of the Sheffield City Region's overall advanced manufacturing employment of 15,659. The AMP accounts for only 3 per cent of all the Sheffield City Region's advanced manufacturing and engineering jobs.

This is not unusual – many of the comparator parks also play small roles in their local economies. Cody for example only contains 3 per cent of Hampshire and the Isle of Wight's advanced manufacturing and engineering jobs.

The AMP is small, however, compared to the other business parks. Figure 7 shows that the AMP employs fewer people than any of the comparator areas. Milton Park employs more than 8,000 people, including more than 2,000 advanced manufacturing jobs. Cody and Milton Park, for instance, have a lower concentration of advanced manufacturing activity than the AMP as a share of work on the site, but a larger total number of advanced manufacturing jobs.

Figure 7: Advanced Manufacturing and Other Jobs



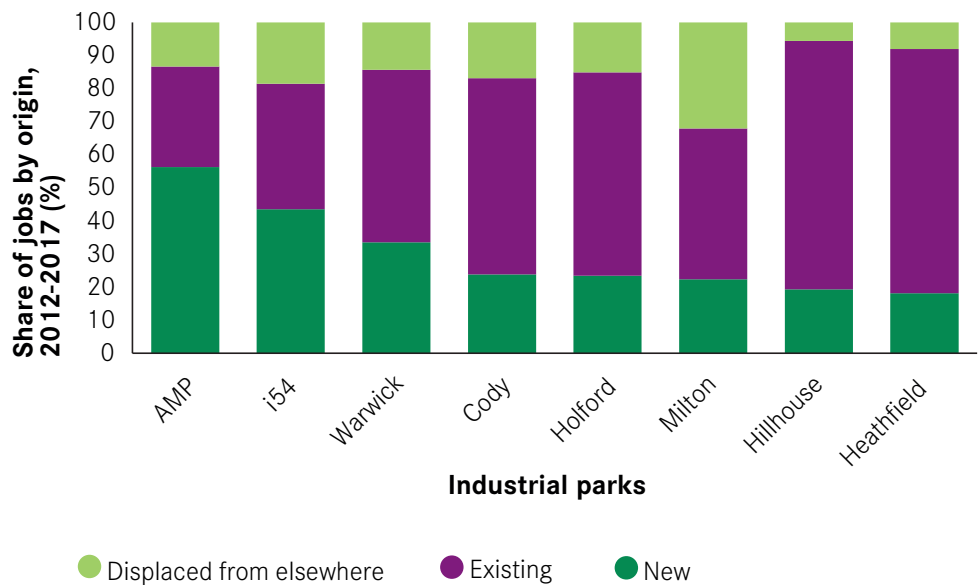
Source: ONS, Business Structures Database, 2017

The AMP is an attractive location within Sheffield City Region’s economy

There is high demand from firms to locate on the AMP and this can be seen in the evidence on jobs and land values.

Most of the jobs on the AMP are new. Figure 8 indicates that over half of the jobs currently on the site have been created since 2012, rather than being already present or simply displaced from a different prior location. This is much higher than for any of the other comparator parks.

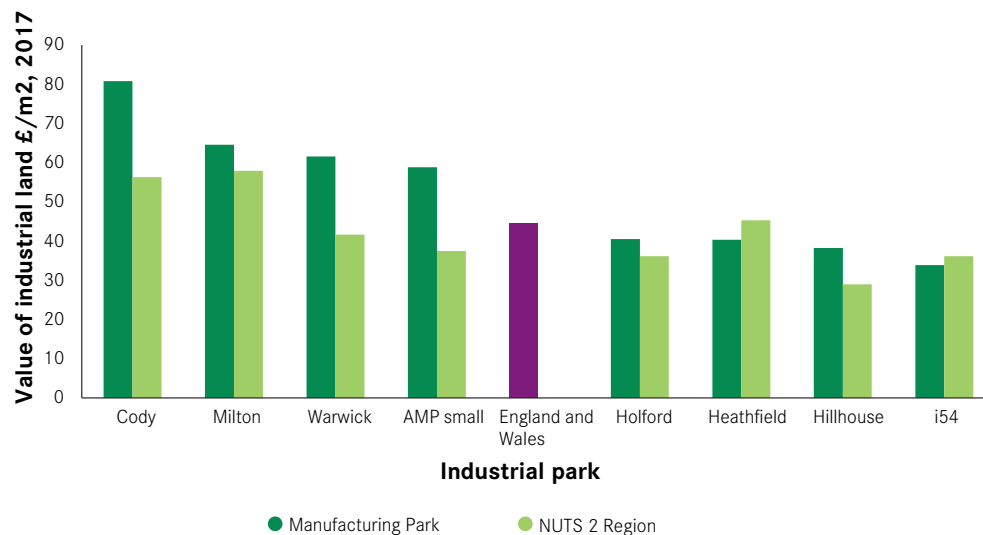
Figure 8: Jobs by firm origin⁶



Source: ONS, Business Structures Database, 2012 – 2017

And these jobs have been created by firms which locate on the AMP even though it is expensive to do so. Figure 9 shows that the price of land on the AMP is high compared to Sheffield City Region as a whole.

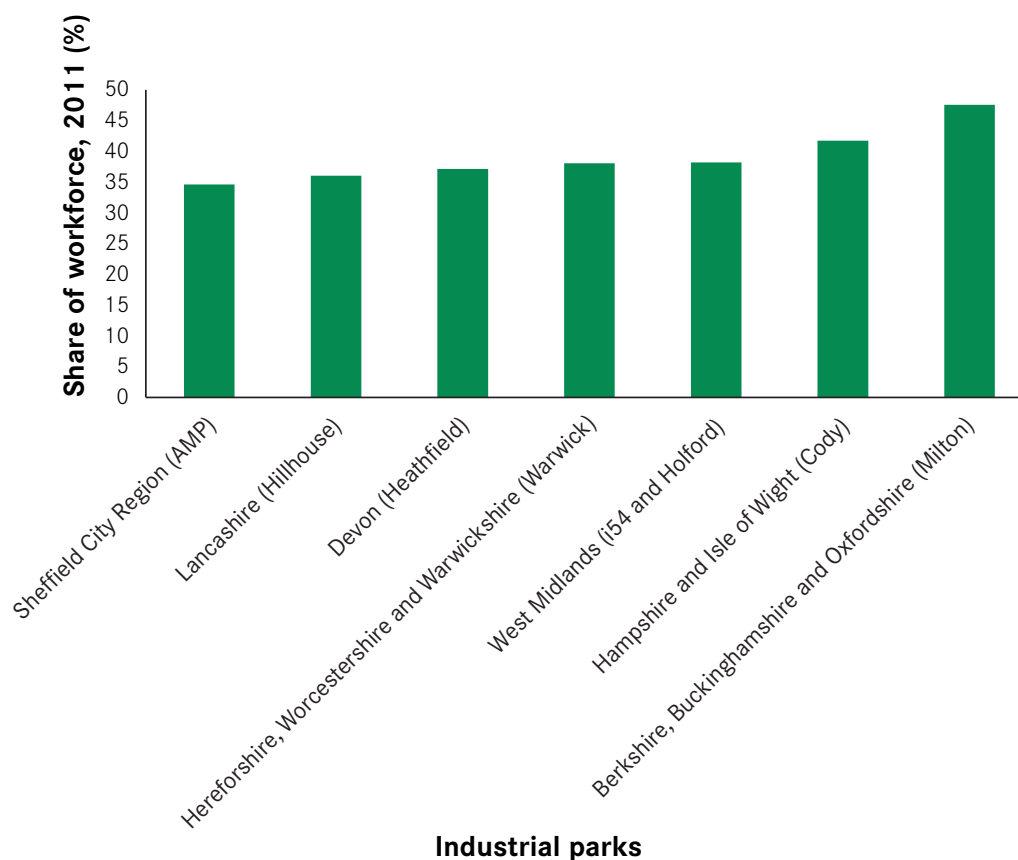
6 The AMP has been in existence since 2006, but this specific data set only goes back to 2012

Figure 9: Median industry rateable value

Source: Valuation Office Agency, 2018

The price of industrial land on the AMP is at a rateable value of £59 per sqm, much higher than in the rest of Sheffield City Region (£38) and the average for England (£44). The value of industrial land on the AMP is comparable to Cody, Milton Park and Warwick in affluent areas of England, and higher than the other comparators in Birmingham, Exeter, and Fleetwood.

This suggests the AMP is a high demand area compared to other advanced manufacturing parks. The AMP's land is as, or more, valuable than these other parks, despite being in a city-region with a much weaker skills base. Figure 10 shows that Sheffield City Region has fewer workers occupying a high-level position (such as managers, engineers, data scientists or lawyers) than any of the regions in which the comparator business parks are located.

Figure 10: Workforce in high-level occupations⁷

Source: Census 2011

There is a large gap between Sheffield City Region and the regions of Cody and Milton parks (Hampshire and Berkshire, Buckinghamshire and Oxfordshire) with the most expensive land. Here, high-level occupations account for 42 and 48 per cent of all jobs, compared to 35 per cent in Sheffield City Region. Advanced manufacturing locates in these other parks in part due to the skills their local economies can offer. This drives up local wages and the price of land.

But, although skills levels in the Sheffield City Region are weaker than in any of the other areas, they are likely to be much higher on the AMP. As mentioned, 66 per cent of all jobs on the AMP are in advanced manufacturing, and on average 64 per cent of all advanced manufacturing jobs nationally are estimated to be high-level occupations.⁸ This divide between the AMP and the rest of Sheffield City Region indicates that the AMP is able to offer benefits to high-value manufacturing activity that the rest of the Sheffield City Region struggles to provide.

⁷ The geography used to compare these parks (some of which are outside cities) is their NUTS 2 region. This is roughly equivalent in scale to the city-region level for those parks which exist outside PUAs – for instance, the NUTS 2 region for Milton Park is the counties of Berkshire, Buckinghamshire

⁸ 2011 Census

Summary

The AMP is a cluster of high-skilled and productive activity. Even though the AMP is expensive to locate on, there are now almost 500 advanced manufacturing jobs on the site, with half of all jobs having been created since 2012.

Understanding what these results mean for national and local industrial strategy requires an understanding of the origins of the AMP, its appeal to firms, and whether the model is replicable in other places.



Advanced Technology Centre

Source: Harworth Group plc

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What is the AMP model?

The AMP combines a research institution, training and graduates from the University of Sheffield, and private sector firms. The impact of the AMP is felt not just by workers and firms on the park though, but by businesses around the country that connect with the research taking place there.

The AMP has taken two decades to arrive at its current position, contingent on the support of large multinationals and a committed university with expertise in the sector. Reproducing the characteristics of the AMP in other places is possible, but will require considerable time and attention to factors such as working with universities and developing a similar open-source research model.

How does the AMRC work?

Most of the facilities of the AMRC network are located on the Advanced Manufacturing Park (AMP). This includes ten purpose-built centres, each specialised in different types of advanced manufacturing activities such as composite manufacturing, structural testing and nuclear research. These specialities are applied to different fields – like aerospace, automobiles and energy– which means member-firms come from a variety of industrial sectors.

Importantly though, only a small number of AMRC industry members are located in the AMP. Most of the AMRC's members are located elsewhere in the UK and the world and send staff to the AMRC on a regular basis to collaborate in research projects.

The AMRC is a centre for research and development rather than production. While a few companies actually carry out small-scale manufacturing on the AMP site, most firms use the facilities to develop new processes and technologies that, if successful, can be scaled up to improve the productivity of their activities elsewhere in the country.

Historical background

The AMRC is a joint intervention between The University of Sheffield and companies in the advanced manufacturing sector that dates back to the 1990s. It supports innovation in manufacturing by conducting R&D with public and private partners.

The roots of the AMRC began at the end of the 1990s with the collaboration between the University of Sheffield and a local cutting tool company called Technicut. This collaboration took the form of a Teaching Company Scheme, a government-funded programme aimed at fostering partnership between industries and universities.

The initiative also coincided with a commitment to the knowledge economy led by the then Science Minister, David Sainsbury. In 1998, the Labour government had pledged to put the commercialisation of scientific knowledge at the heart of its industrial policy and produced a white paper on how science could enhance economic competitiveness.

This collaboration developed further with the participation of Boeing, the American aircraft manufacturer. Boeing was looking to develop “Centres of Excellence” for research and development, and chose Sheffield City Region. The AMRC was officially established in 2001 – initially called South Yorkshire Centre of Excellence.

Yorkshire Forward, the regional development agency, offered the AMRC the opportunity to be based at the former Orgreave Colliery Site which became the AMP in 2006.

Funding for the project came from the Yorkshire regional development agency, national government funding, European regional development funds and university investment. Up to 2015, the AMRC had received £70m from the Government and a further £70m of European funding.

Timeline

1998	AMRC founders Professor Keith Ridgway of the University of Sheffield and Adrian Allen of Technicut begin to discuss academia-industry collaboration
2001	The University of Sheffield AMRC with Boeing is established.
2006	The regional development agency Yorkshire Forward opens the AMP Technology Centre providing office and meeting spaces for high-value manufacturing companies
2008	Opening of the AMRC Rolls-Royce Factory of the Future
2011	Completion of the Nuclear AMRC – led by the University of Sheffield with Rolls-Royce, funded with £15 million from the Department for Business, Innovation and Skills and £10 million from the regional development agency Yorkshire Forward
2013	First 250 apprentices begin at the AMRC Training Centre
2014	Initial research at the Medical AMRC
2016	Expansion of the AMP Technology Centre
2017	McLaren announces that it will build supercar chassis in Sheffield City Region – co-locating alongside its longstanding research partner the AMRC

2017	Boeing announces a manufacturing centre to be built in Sheffield alongside the AMRC, its first manufacturing facility in Europe
2018	McLaren and Boeing open their new manufacturing facilities

What makes the AMRC model different?

There are three elements that make the AMRC model different from other industrial parks:

- Cross-industry collaboration - it is designed to encourage manufacturing firms to innovate and work together
- Focus on research - it provides members access to high-quality manufacturing research produced on the AMP, and to a nationwide network of manufacturers
- Access to expertise - it allows firms to have access to, and work with, a highly-skilled workforce, trained for advanced manufacturing on the AMP through the University of Sheffield

Helping firms produce and exchange of knowledge

Innovation is crucial for exporting firms' success in highly competitive markets. But R&D is expensive – it requires specific facilities, machinery, and highly-trained staff. The AMRC addresses these issues in two ways.

First, it reduces costs and risks in R&D investment by pooling resources. Rather than each company individually investing in research, facilities, machinery and staff, the AMRC allows members to pool those investments. This means that costs and risks are shared and thus reduced.

R&D can also be risky, as there is no guarantee that research will bring positive or usable results. For this reason, many companies, in particular, smaller firms, find it difficult to engage in innovation. The AMRC overcomes this by facilitating manufacturers' R&D processes by reducing risk and distributing knowledge across the network of member firms, regardless of size.

Second, the AMRC helps firms exchange knowledge. Firms work with the AMRC and each other to develop new ideas and collaborate on projects, primarily through the AMRC's "open-source" research model. Research that occurs through the AMRC is not patented and is instead made available to firm members of the AMRC network in return for membership fees.

Research programmes are agreed by a board comprising the university and firm-members, ensuring alignment across research projects and guaranteeing that the research is valuable for and usable by members. This, in turn, means that there is no need for patents for research produced on the site. Members can also conduct their own individually-funded research with the AMRC.

The example of BAE Systems in Case Study 1 highlights how the AMRC as a place enables collaboration that can help member companies innovate and become more productive.

Case Study 1: Partnering with the AMRC to improve productivity

The AMRC was working on a research project to enable robots to accurately machine holes in composite aircraft components. After collaborating with KUKA Systems the project matured into a production system. BAE Systems saw the potential to integrate this method into its manufacturing processes and has now installed the technology in its UK factories in Preston and Blackpool, where it will be used to process a wide range of composite components for military aircraft.

This highlights that spillover effects of innovation are not local. The core research and high-value work took place on the AMP, while the output from the research was applied to support production line activity which takes place in other parts of the country.

Access to research to improve production in other places

Most firms with operations at the AMP conduct very little production on the site itself, and some members of the AMRC have no permanent presence on the AMP at all. But these companies benefit from the research that takes place in the AMRC because they use the innovation to improve the productivity of their production processes in other parts of the country.

This access to the AMRC's research was reported in our interviews with member firms, as one of the main benefits of being part of the network. Some companies – even those which are not involved in advanced manufacturing – tap into the research on an ad hoc basis, but their involvement does not justify relocating to the AMP with the high land costs that it requires (as in Case Study 2). Even though many member firms do not have a permanent presence on the AMP, they regularly send staff to work, collaborate, and network on the park.

Case Study 2: Non-advanced manufacturing experiments with the AMRC

A Sheffield knife maker based elsewhere in the Sheffield City Region worked with the AMRC Design and Prototyping Centre to design small production runs of bespoke 3D printed titanium knives. Using advanced 3D printing technology new designs were created – in this case, the blade and the handle are integrated, with the handle moulded and customised to a chef's hand. This is an example of how non-advanced manufacturing firms can also tap into the research that takes place on the AMP. The AMRC's expertise in metal cutting, 3D printing and manufacturing design has been applied to a range of manufacturing activities beyond aerospace and the automotive industry.

Crucially, the existence of this network of firms in and out of the AMP means that on-site activities have benefits beyond Sheffield City Region. Firms use the AMRC to carry out the high-skilled, high-value part of their work. But companies later integrate new technologies and processes on their production lines in other parts of the country where land and the cost of labour is cheaper than it is on the AMP (Case Study 3).

Case Study 3: Using Sheffield City Region's knowledge to enhance production elsewhere

Rolls-Royce worked with the AMRC to improve the manufacturing process of key components in aerospace manufacturing, called aero-engine discs.

The materials used to make the discs are difficult to carve and require complex manufacturing processes. AMRC engineers used simulation tools to guide the fixture design and machining of the disc, to improve the fabrication process. This and other innovations developed by the AMRC allowed Rolls-Royce to reduce the time it takes to manufacture each disc by 50 per cent. Rolls-Royce is now implementing the technology in its manufacturing facility in Sunderland.

This shows the importance of the AMRC as the place to generate the high-value outputs of the manufacturing process. Despite Rolls-Royce being a company with large resources and R&D facilities of its own, gaining access to the AMRC research and collaborating with its engineers in Sheffield provided an advantage for production facilities elsewhere in the country.

Access to skilled workers and staff training

Graduates and PhD students

The AMRC arranges for engineering professionals from the University of Sheffield to work with firms on the AMP site. The opportunity to work with and hire graduates and PhD students was reported in interviews as one of the main benefits of locating on the AMP.

The AMRC runs a graduate programme that offers placements in a variety of advanced manufacturing fields. The programme is 24 months long and allows engineers to work on multiple projects across different sectors and firms.

The AMRC and the University of Sheffield have also implemented an Industrial Doctorate Centre which trains postdoctoral engineers and PhD students, with time shared between the university and the AMRC. The programme is fully funded by firms, meaning that the four-year degree is free for students.

Apprentices

Over 1,000 apprentices have been trained on the AMP since it was established. The AMRC has developed a system of matching and training, where an extension of the university, the AMRC Training Centre, matches apprentices with companies and provides the academic side of the training. The training centre is based on the AMP and managed by the AMRC which enables its activities to be directly connected with the wider research activities as defined by the AMRC board and by individual member companies.

The training centre runs several apprenticeship programmes in advanced manufacturing at different levels of qualification – for instance, it recently introduced degree apprenticeships, which provide qualifications equivalent to a university bachelor's or master's degree.

AMRC research staff and staff training

There are approximately 600 public sector workers employed by the University of Sheffield on the AMP.⁹ Of these, about 350 are professional engineers and researchers, who are conducting and leading the different research projects that have been agreed by the board. Along with firms' employees, they form the core of the professional staff. The AMRC also provides training to firms' employees, through development courses.

Implications of the AMP model for the Industrial Strategy

The impact of the activities that take place on the AMP operates at two different scales – the diffusion of knowledge and practice is across the economy of Sheffield City Region as well as the wider national economy. The AMP is therefore relevant and important to both local and national policymakers focused on the industrial strategy.

National Industrial Strategy

The AMRC is explicitly a national asset as part of the UK Catapult system of research collaboration with industry, as many of the benefits it produces in Sheffield City Region are felt around the country. As national Catapult facilities, the AMRC and nuclear AMRC work with firms across the UK. Research at the AMRC is linked to new production facilities in Sunderland and Broughton in North Wales. This implies that the Government's role should be to support this diffusion of knowledge from the AMRC and other advanced manufacturing sites.

For instance, Boeing and McLaren have each recently opened up large research and production plants close to and on the AMP respectively, with both firms motivated partly by the benefits the site offers in terms of skills and research. This raises a consideration for the Government. If this new activity is primarily production lines for these firms, then it is of less relevance to the National Industrial Strategy than the experimental research that helps many firms across the country, which has until now characterised the AMP.

The opposite applies too – if other places are able to offer firms similar benefits to the AMP, then they are relevant to the National Industrial Strategy. The AMRC is expanding into other locations, including Infinity Park in Derby and Broughton. Achieving similar success on these other advanced manufacturing sites within the National Industrial Strategy will require a similar focus on research and innovation rather than assembly lines for mass production.

This will likely require government funding. Achieving the impact that the AMRC has achieved has required £70m of funding from national government and the former regional development agency as well as £70m in European funding. It will also require time – it took 20 years for the AMP to reach its current scale and scope of operations.

⁹ Source: University of Sheffield. This is distinct from the figure of 499 advanced manufacturing private sector jobs on the AMP.

Impact of Brexit

Although the future relationship between the UK and the rest of the European Union remains uncertain, high-skilled European workers have played an important role in the AMRC due to Freedom of Movement. It is difficult to quantify the number of European citizens working on the AMP, but any restrictions on high-skilled migrants after the UK has withdrawn from the European Union will make it more difficult for the AMP to access the high-skilled workers that the AMRC and its partner firms need. Any disruption to these flows risks damaging the productivity of not just firms on the AMP, but those companies the AMP works with around the country, such as Airbus in Broughton.

Local Industrial Strategy

The role Sheffield City Region plays in supporting the AMRC is different given the nature of the impacts that accrue locally rather than nationally. There is a role for local government in facilitating the diffusion of AMRC research to manufacturing firms in the city region. But its principal role is to focus on policies to support high-skilled exporting work: skills, transport and planning.

Local government interventions on the AMP have been primarily through purchasing land for assembly. The Sheffield City Region should enable the AMP to expand onto land nearby if there is demand for it, ensuring planning decisions are dealt with proactively and supported by the provision of adequate transport and infrastructure.

However, this expansion should not be subsidised by the Sheffield City Region purchasing land on behalf of the AMP. The appeal of the AMP to firms is clear and reflected in the price of land. Activity that can benefit from locating on the site will be prepared to pay the premium that the land values require, because the AMP's benefits can only be accessed on that site.

The higher cost of land may at this point slow expansion, but this is a consequence of the strong demand to locate on and near the site. Provided adequate land nearby is protected for industrial use, further growth of the AMP should eventually occur.

If the AMRC is to be a catalyst for growing the size of the advanced manufacturing industries in Sheffield City Region, local government will need to ensure that manufacturing firms in the city region can tap into the research taking place on the AMP. Involving existing local manufacturing firms that want to participate in R&D initiatives or consume and apply research outputs should be a distinct objective for the Local Industrial Strategy. Local government in Sheffield City Region should help local firms that want to tap into this national asset. This could be through informal convening or formal policy such as research grants for local firms such as those outlined by Centre for Cities' sister organisation the What Works Centre for Local Economic Growth.¹⁰

But local government will primarily need to focus on broader fundamentals of the local economy, especially the city-region's wider skills deficit. The AMRC's ability to match workers with industry-specific training and employers is important to the AMP's appeal. But high-skilled exports do not just require specialist skills

¹⁰ <https://whatworksgrowth.org/policy-reviews/innovation/>

such as engineering or graphic design. They also need transferable skills such as communication, numeracy, or management which can be used flexibly by employers.

Local government's broader role should be to focus on improving these transferable skills, as they are needed by firms on the AMP as well as by other high-skilled exporters. Achieving this in the context of local industrial strategies means improving learning outcomes at every stage of the education process, including nurseries, schools, and higher and further education.



Above: The AMRC's Knowledge Transfer Centre

Next page: Aerial view of Advanced Manufacturing Park and a map showing its location

Source: Harworth Group plc



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Conclusions and recommendations

Summary

The AMRC is at the core of a cluster of high-skilled exporting work that benefits the local and the national economy. A total of 499 advanced manufacturing jobs in the private sector exist on the site, and manufacturing firms from all over the country and the world are engaging with the Sheffield City Region, not because it is a producer of steel, but because it is a producer of knowledge.

The AMP reinforces the importance of place as a means of integrating the other foundations of the Industrial Strategy. Rather than intervening in specific sectors, to improve national economic performance, the Government should support places where knowledge is created and flows. Likewise, local government should work to improve the capacity of local economies to create knowledge.

The AMP, as an expensive place to locate, is distinct from the rest of Sheffield City Region's economy. Instead, it more closely resembles some of the business parks in local economies with stronger skill bases, more knowledge spillovers, and more success in attracting high-skilled exporting work. If Sheffield City Region does manage to improve its appeal to such work, the cost of locating in the city region will increase, but firms will be prepared to pay this premium to access a labour market with more valuable skills.

Other places considering advanced manufacturing sites, such as Tees Valley, Sunderland, and Glasgow, should recognise the importance of ideas and the co-location of high-skilled work to the AMP's success. Local universities should be involved from the beginning, and research results should be made accessible to other participants on the site. In addition, for these new advanced manufacturing sites to successfully play a role in improving local productivity and wages, low-cost mass manufacturing should be prevented from locating on these sites.

Policy Recommendations

The National Government should:

- **Encourage other advanced manufacturing parks to replicate the AMRC's university partnership and open-source research model.** The collaboration and knowledge-sharing that the AMP offers is a critical element in its appeal to firms. A similar approach to research and university participation should be encouraged on other advanced manufacturing sites under development, particularly those receiving public money.
- **Expand the AMP and other advanced manufacturing estates in response to demand.** The cumulative public investment required to establish the AMRC and AMP as they are today was £140m. This can be justified as part of a National Industrial Strategy. However, there is a risk that if many more advanced manufacturing sites are established there will not be enough demand to justify the investment they will require. Due to the highly specialised and skilled nature of the work that takes place on the AMP, a “build and they will come” approach will struggle to succeed. The creation and expansion of more parks should only take place with Government support provided there is sufficient interest for more sites from the private sector.
- **Devolve the Adult Education Budget to metro mayors.** Sheffield City Region is in the best position to understand the skills gaps in its economy and to work with local providers and employers to address them. But the devolution of skills budgets from central government remains incomplete, including in Sheffield City Region. The Sheffield City Region devolution deal should be completed, unlocking access to control of the adult education skills budget in Sheffield.
- **Increase the intensity and application of R&D.** Government is already committed to working with firms and academia to spend 2.4 per cent of GDP by 2027 on R&D. Although the increased funding is essential, equally important is maximising the impact of national and local interventions. The evidence gathered by the What Works Centre for Local Economic Growth on innovation initiatives shows that there is good evidence that R&D grants, loans, and tax credits improve innovation. But this same evidence base also indicates that the application of R&D by firms in different places is uneven.¹¹ Ensuring not just that innovation increases overall, but that firms in cities across the country can tap into national initiatives like the AMRC, must be a priority for the Government in its attempts to solve Britain's productivity puzzle.

Local Government should:

- **Support the knowledge economy and exporting jobs as a whole, rather than one specific sector.** The success of the AMRC does not come from advanced manufacturing alone, but because it provides the right environment and skills for knowledge-intensive firms to

11 <https://whatworksgrowth.org/policy-reviews/innovation/>

collaborate. In the context of local industrial strategies' goal to increase productivity, cities should focus on providing the characteristics this activity requires rather than on any one sector in particular. Not every city will be able to have its own AMP, but they can all improve their capacity to house high-skilled exporting work broadly. This means focusing on horizontal policies that drive growth: skills, planning and transport.

- **Enable diffusion of innovation.** The AMRC's value as a national asset is in how it improves the productivity of the firms it partners with through R&D. For Sheffield City Region and other areas of local government, helping local firms connect with the AMRC and similar assets elsewhere is local industrial strategy. This implies a convening role for local government in identifying local manufacturing firms which have the potential and desire to engage in R&D and helping them to do so through institutions like the AMRC.

Appendix

Advanced manufacturing definition

1920 : Manufacture of refined petroleum products; 2012 : Manufacture of dyes and pigments; 2015 : Manufacture of fertilisers and nitrogen compounds; 2020 : Manufacture of pesticides and other agrochemical products; 2059 : Manufacture of other chemical products n.e.c.; 2110 : Manufacture of basic pharmaceutical products; 2120 : Manufacture of pharmaceutical preparations; 2229 : Manufacture of other plastic products; 2343 : Manufacture of ceramic insulators and insulating fittings; 2344 : Manufacture of other technical ceramic products; 2349 : Manufacture of other ceramic products; 2540 : Manufacture of weapons and ammunition; 2561 : Treatment and coating of metals; 2611 : Manufacture of electronic components; 2612 : Manufacture of loaded electronic boards; 2620 : Manufacture of computers and peripheral equipment; 2630 : Manufacture of communication equipment; 2640 : Manufacture of consumer electronics; 2651 : Manufacture of instruments and appliances for measuring, testing and navigation; 2652 : Manufacture of watches and clocks; 2660 : Manufacture of irradiation, electromedical and electrotherapeutic equipment; 2670 : Manufacture of optical instruments and photographic equipment; 2680 : Manufacture of magnetic and optical media; 2711 : Manufacture of electric motors, generators and transformers; 2712 : Manufacture of electricity distribution and control apparatus; 2720 : Manufacture of batteries and accumulators; 2731 : Manufacture of fibre optic cables; 2732 : Manufacture of other electronic and electric wires and cables; 2733 : Manufacture of wiring devices; 2790 : Manufacture of other electrical equipment; 2811 : Manufacture of engines and turbines, except aircraft, vehicle and cycle engines; 2812 : Manufacture of fluid power equipment; 2813 : Manufacture of other pumps and compressors; 2814 : Manufacture of other taps and valves; 2815 : Manufacture of bearings, gears, gearing and driving elements; 2822 : Manufacture of lifting and handling equipment; 2824 : Manufacture of power-driven hand tools; 2825 : Manufacture of non-domestic cooling and ventilation equipment; 2829 : Manufacture of other general-purpose machinery n.e.c.; 2830 : Manufacture of agricultural and forestry machinery; 2841 : Manufacture of metal forming machinery; 2849 : Manufacture of other machine tools; 2891 : Manufacture of machinery for metallurgy; 2892 : Manufacture of machinery for mining, quarrying and construction; 2893 : Manufacture of machinery for food, beverage and tobacco processing; 2894 : Manufacture of machinery for textile, apparel and leather production; 2895 : Manufacture of machinery for paper and paperboard production; 2896 : Manufacture of plastics and rubber machinery; 2899 : Manufacture of other special-purpose machinery n.e.c.; 2931 : Manufacture of electrical and electronic equipment for motor vehicles; 3020 : Manufacture of railway locomotives and rolling stock; 3030 : Manufacture of air and spacecraft and related machinery; 3040 : Manufacture of military fighting vehicles; 3250 : Manufacture of medical and dental instruments and supplies; 7112 : Engineering activities and related technical consultancy; 7120 : Technical testing and analysis; 7211 : Research and experimental development on biotechnology; 7219 : Other research and experimental development on natural sciences and engineering



May 2019

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