
Book Section:
Wilson, J. (2018) Public education institutions as providers of private training programs: Degree apprenticeships in the United Kingdom. In: McGrath, S., Mulder, M., Papier, J. and Suart, R., (eds.) Handbook of Vocational Education and Training: Developments in the Changing World of Work. Springer . ISBN 9783319945316

https://doi.org/10.1007/978-3-319-49789-1_102-1

Public education institutions as providers of private training programs: Degree Apprenticeships in United Kingdom

John P. Wilson, Management School, University of Sheffield; Department for Continuing Education, University of Oxford, UK. j.p.wilson@sheffield.ac.uk

Abstract

The Humboldt model of higher education describes two main missions of universities, i.e. teaching and research; however, this has increasingly been complemented with the third mission of connecting with business and communities through knowledge transfer, valorisation, engagement and training. One important dimension of this third mission is the provision of training programmes which bring numerous benefits to universities and their constituent communities. Yet, closer inspection of this training reveals a complex array of provision and it is argued that the term 'knowledge transfer' provides a more accurate picture from a learning perspective.

In recent decades, the UK has maintained a laissez-faire approach allowing industry to respond to the market; however, recently there has been a significant change with a new interventionist industrial strategy. The *Industrial Strategy* document described the University of Sheffield's Advanced Manufacturing Research Centre (AMRC) as a role model for innovation and economic growth. The AMRC Training Centre will be discussed to provide a practical context with regard to degree apprenticeships and other training which is delivered to employees of approximately 300 companies, including Boeing, McLaren and Rolls Royce which have established manufacturing facilities at the AMRC.

(up to 250 words)

Keywords:

degree apprenticeships; third mission; Advanced Manufacturing Research Centre; University of Sheffield

1.1 Introduction

> *"Just as castles provided the source of strength for medieval towns, and factories provided prosperity in the industrial age, universities are the source of strength in the knowledge-based economy of the twenty-first century."*
>
> Lord Dearing, 2002

The Humboldt perspective of universities describes two main missions of teaching and research; increasingly, however, this has been complemented by a third mission – that of engaging with local, national and international communities and businesses (Schimank and Winnes, 2000). The third mission is also known as third stream, triple helix, knowledge triangle, knowledge transfer, valorisation and in the United States as outreach and

engagement. This repurposing of the roles of universities has emerged for a number of reasons:

- Governments encouraging university – industry relationships in a triple helix (Etzkowitz and Leydesdorff, 2000).
- Limitations on state funding for universities (Universities UK, 2016c)
- Demands by society for less isolationism and greater involvement from the 'ivory towers' of universities (Reid, 2013).
- Businesses wishing to benefit from the research conducted in universities (Abramovsky et al, 2007).
- Open innovation strategies by businesses which no longer exclusively conduct in-house R&D seeking out research and innovation from other sources including universities (Chesbrough, 2006).

Historically, higher education institutions (HEI) have provided a range of vocational education programmes which can be defined: "as being designed to offer a pathway to a specific career or profession –by deploying specific, technical skills used in that career" (UUK, 2016a: 11). Using this definition, Universities UK examined the Higher Education Statistics Agency (HESA) student records as well as the Skills Funding Agency's Individualised Learner Record to categorize nine vocational study areas: architecture, building and planning; computer science and ICT; education and training; engineering; medicine related subjects; law and legal studies; medicine and dentistry; social work and care; and, veterinary, agriculture and environment. Based on the definition above, 42% of universities and 54% of further education (FE) colleges provided education which can be considered vocational.

In addition to this student focussed vocational education, higher education institutions and further education colleges also provide external training and continuing professional development. The title of this chapter: "public education institutions as providers of private training programmes," at first glance, would appear to be a relatively distinct area but the closer one investigates it the more diverse it becomes. Inspection of this training reveals a complex array of provision from short bite-sized training to long extensive programmes; in-house / on campus; certificated / non-certificated; bespoke / off-the-peg; face-to-face / distance, online learning; government supported programmes / individual – company sponsored, etc.

To add further complexity, definitions of training are blurred and porous, overlapping with vocational education, learning, development and knowledge transfer (Wilson, J. 2012). For example, the Manpower Services Commission (1981:62) defined training as:

> "a planned process to modify attitude, knowledge or skill behaviour through learning experience to achieve effective performance in an activity or range of activities. Its purpose, in the work situation, is to develop the abilities of the individual and to satisfy the current and future needs of the organisation."

This definition of training is also relatively limited in its scope to provide a window on university – business links and there are also other complications in defining 'private training programmes'. Do these mean only direct face-to-face training should be considered? What about when training is part of a wider provision of knowledge transfer e.g. training in the use of technology, on-the-job training etc? The range and variety of learning can be summarised

in the 70: 20: 10 model of learning and development in which 70% of a person's total learning results from challenging assignments; 20% from interactions with workplace colleagues; and, 10% from structured training programmes (Lombardo and Eichinger, 1996). Training is too narrow a term to be fully practicable in discussing the wide range of learning opportunities which occur in the current environment. By contrast, knowledge transfer is more widely applicable and appropriate as the following definition illustrates:

> "Within a modern, knowledge driven economy, knowledge transfer is about transferring good ideas, research results and skills between universities, other research organisations, business and the wider community to enable innovative new products and services to be developed" (Office for Science and Technology, 2002: 63).

It is with the above considerations in mind that this chapter will study university third mission initiatives and explore some governmental training delivery interventions by universities. Next it will describe the historical development of apprenticeships leading to the new degree apprenticeships. It will then describe the UK's industrial strategy and how the University of Sheffield's Advanced Manufacturing Research Centre is contributing towards innovation and economic growth. And finally, it will describe the Apprenticeship Standard for Postgraduate Engineers.

1.2 The Third Mission: University - Business Collaboration

The third mission is becoming increasingly important for universities, and the representative association for UK universities described how: "Universities engage in a wide range of knowledge exchange activities, such as long-term collaborative research programmes, consultancy, and bespoke training" (Universities UK, 2015: 12).

A Higher Education-Business and Community Interaction survey of 161 UK higher education institutions identified that 108 provided continuous work-based learning and 150 universities delivered bespoke courses on campus or business premises (HESA 2015). Employers were involved in content development and curriculum review in many of the programmes and 113 out of 161 ranked this involvement as four or five out of five. Moreover, businesses which collaborated with universities were six times more likely to report the introduction of product innovations (Howells et al, 2012). In addition, 28% of employers were directly involved with degree programme advisory boards and course design (Universities UK, 2015).

The *Lambert Review of Business – University Collaboration* (Lambert, 2003) noted that the continuing professional development market was valued at £23bn and the Council for Industry and Higher Education estimated that universities only accounted for £250m. These figures indicated substantial financial opportunities for universities which adopted an entrepreneurial approach. Perhaps more importantly, a list of potential benefits between businesses and universities included:

- applied research in advanced technologies;
- bespoke collaborative degree programmes;
- collaborative research;
- education of graduates;

- enterprise education for graduates;
- helping government agencies encourage major employers to invest in the UK;
- higher-level apprenticeships;
- in-company upskilling of employees;
- industry-sector foundation degrees;
- 'science' park developments;
- spin-out companies;
- support for entrepreneurs. (Wilson, T., 2012: ii)

1.3 Competition and Collaboration Among Universities

It has been argued that competition amongst universities has encouraged diversity, effectiveness and efficiency at the same time as ensuring excellence (Wilson, T. 2012). Moreover, no single university offers business collaboration across all dimensions with the result that diversity provides strength. One downside of this competition is that there is the potential for universities to chase business customers in pursuit of financial returns even when they do not have a strong offering. It is not unusual for universities to talk up their excellence but this needs to be underpinned with substance.

An alternative approach for university leaders might be to emphasise the complementary strengths different universities offer. Universities should be honest about what they can provide by mutually recognising the abilities of other universities and, where relevant, recommending other universities. Without this perspective competition might become a weakness (Wilson, T. 2012).

One strategy to overcome the limitations of competition is the concept of collaborative advantage (Kanter, 1994). This involves universities working in consortia and alliances to provide a broader portfolio to the business community, for example, Universities West Midlands (2018) which represents 12 universities provides a website portal which encourages interest in working with these universities and: "It fosters collaborative solutions and strong partnerships in support of economic, social and cultural wellbeing and public benefit." (universitieswm.co.uk, 2018).

1.4 Failure of University – Business Collaboration

Although there are many benefits of university – business collaboration, it may not always be successful for a range of reasons which are summarised below:

1. Business needs do not fit with a university's strategy and mission.
2. A university's capacity may not be available within the timescale required by the business.
3. A capability mismatch where a university does not have the skills or facilities needed.
4. The bidding cycle for external funding may not match the timescales required by the business.
5. Universities should provide services at full economic cost and this may sometimes be more than businesses are willing to pay.

6. The investment by the university does not provide a sustainable payback period.
7. There is a mismatch between expectations and objectives.
8. Ownership of intellectual property can prejudice collaboration.
9. There may be different views about indemnities and liabilities between partners. (Wilson, T. 2012)

A helpful piece of guidance to avoid some of the challenges described above is give a clear and prompt response to collaboration enquiries and requests. No response or unnecessary delays can cause frustration and adversely impact on reputation and other collaborations with the business. One helpful strategy used by some universities is to say: "No, because…" and quickly refer the business to other universities or providers (Wilson, T. 2012).

A consultancy approach is sometimes more effective for universities than only offering a menu of training programmes. In an interview a stakeholder organisation representative stated: "There needs to be much more understanding [of employer needs from universities] first. Rather than 'are you interested in buying training off us?' […] It's about understanding what the employer's pain is […] and what model will fix that pain" (Universities UK, 2016: 16).

In spite of these potential shortcomings, there has been an increasing appetite by higher education institutions to build links with businesses and communities. These connections also have been encouraged by government initiatives some of which are described below.

1.5 Examples of University – Business Training and Knowledge Transfer

One of the most important factors supporting labour productivity is human capital which the OECD (2001: 18) described as: "The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being." Universities are in a prime position to support the development of human capital and the collaboration between universities and businesses has been ongoing for many years. For example, the establishment of many civic universities in the UK were linked to the provision of medicine and engineering, and the former polytechnics also provided a range of offerings to business and industry. In an investigation of labour market training interventions and the links between education institutions and business / industry from 1839 – 2010, hundreds of initiatives were identified (Wilson, 2011) a few of which will be briefly described below.

One initiative was Professional, Industrial and Commercial Updating (Pickup) which launched in 1982. Its aim was to provide pump-priming finance to encourage colleges, polytechnics and universities to increase their involvement with industry and commerce and deliver self-financing vocational courses for companies and people in employment (HM Inspectors, 1990). Associated with the Pickup programme were Local Collaborative Projects which ran between 1984-88. These were a combined initiative supported by the Manpower Services Commission and Education Department whereby employers and education providers in both HE and FE developed links to increase the amount of education and training updating (HM Inspectors, 1990).

Another initiative encouraged by government was the "Higher Education Reach-out to Business and the Community Fund (HEROBC)" which subsequently became the Higher

Education Innovation Fund (HEIF) (Goddard and Puukka, 2008). This began in 2001 to provide a range of training and third mission activity and continues today.

Yet a further initiative was the Teaching Company Scheme which encouraged companies to partner with universities to benefit from the transfer of knowledge provided by graduates who were known as teaching company associates. In 2003, this scheme was replaced with Knowledge Transfer Partnerships which involved both universities and further education colleges. A KTP associate worked with a company on a business development project (Wilson, 2011).

2.1 A Brief History of UK Apprenticeships

During the Middle Ages in western Europe, merchants, landowners and skilled tradesmen grouped together and formed guilds focussing on specific occupations e.g. the Cutlers' Company (cutlery and metal working) was established in 1624 and, among other responsibilities, oversaw the binding of apprentices to employers. The guilds were the first organisations which systematically managed the relationship between employers and employees.

In the UK, the state first became involved with training with the introduction of the Statute of Artificers 1406 (a person who made artefacts). The statute legislated that, "every man or woman of what state or condition that he be, shall be free to set their son or daughter to take learning at any school that pleaseth them within the realm" (De Montmorency 1902 p. 28-29). A subsequent Statute of Artificers 1563 declared that young people were "to be enstructed or tought in any of the Artes Occupacions Craftes or Misteries which they or any of them [the masters] doo use or exercise" (De Montmorency 1902 p. 71).

In the 19th century apprenticeships expanded to new industries including electrical activities, engineering, and shipbuilding with approximately a quarter of a million apprentices during the 1960s. By the 1990s the number had declined to 50,000 due to economic difficulties; a decline in manufacturing; and young people attending school for longer. Also, many apprenticeships (normally five-years length) were not matching the requirements of the labour market and the learning was not always of an appropriate quality. This resulted in government intervention with the introduction of Modern Apprenticeships which raised numbers to 180,000 by 2010.

Although the numbers of apprenticeships increased during this period there was concern about their quality and suitability (Fuller and Unwin, 2003). Some of these apprenticeships were of short duration and their relatively low level resulted in a reduction in demand from some employers and potential apprentices (Winch and Clarke, 2003; Toner, 2008). A review of vocational education by Wolf (2011) observed that the UK's system of technical education was weaker than most other developed nations. Subsequently, another report by Wolf (2015: 1) described it as a dysfunctional and "broken training system" in which modern apprenticeships did not resemble traditional apprenticeships and had contributed to a decline in training by employers. Moreover, government provided funding for training which many employers would have delivered anyway.

This recognition of a dysfunctional training system led to the Richard Review of Apprenticeships (2012: 15) which described an important observation: "Elsewhere, in Europe

and beyond, apprenticeships are held in very high regard. This is a very different world from England where all the prestige is tied to a university education and all alternatives are considered second class."

In 2016, the average level of UK productivity was calculated as 15.1% lower than the combined productivity of the other G7 nations. For the individual nations UK productivity was above Japan (by12.0%) and above Canada (by 3.4%); however, it was lower than Italy (9.0%); USA (21.8%); France (22.3%); and Germany (25.6%) (Office for National Statistics, 2018). A report by HM Treasury (2015) suggested a number of strategies to resolve this productivity problem including increasing the quality and quantity of apprenticeship training because of the correlation between higher skills and productivity levels; degree apprenticeships and introducing a training levy. Higher level skills and education are linked to higher productivity and the Department for Business, Innovation and Skills (BIS: 2013: 3) calculated that a 1% increase in the workforce possessing a university degree increased long-run productivity by 0.2-0.5%. It appeared that linking universities and apprenticeships somehow might provide a partial solution to the problem of skills and productivity.

2.2 Degree Apprenticeships

2.2.1 An International Perspective

This chapter focuses on the context and development of degree apprenticeships in the UK, but it should also be acknowledged that previously other countries have developed hybrid forms of learning which combine vocational education and training (VET) with higher education. This provision often varies depending on national circumstances and a detailed consideration of these is beyond the scope of this chapter; however, it is important to draw attention to some examples to illustrate the scale of these developments and the potential opportunities for learning from these wider experiences.

The separation of VET and HE in Austria, Germany and Switzerland was described by Baethge (2006) as an "educational schism" but increasingly there has been blurring of the distinctions between the two (Graf, 2016). This has occurred for a number of reasons including: socio-economic factors; demands for higher skills; and the Bologna and Copenhagen agreements encouraging movement between VET and HE (Powell and Solga 2010).

One example is the German 'Stuttgarter Modell' which began in 1972 as a cooperative initiative between companies such as Daimler, Bosch and SEL and the state minister for education and culture of Baden-Württemberg. It was subsequently called 'Berufsakademie Baden-Württemberg' and is now called 'Duale Hochschule Baden-Württemberg', or 'Baden-Württemberg Cooperative State University' (DHBW). This cooperative (work-integrated) education combines theory and practice through university education and on-the-job training in companies (Duale Hochschule Baden-Württemberg, 2018). A similar model can also be found in South America where the Duale Hochschule Latinoamericano (2018) combines academic and work-based learning in Colombia, Mexico, Peru and Ecuador.

The sources of funding for students' education and training vary depending on the country, and can be employer, state, company, student or combinations. Below, we will discuss the

UK situation in which the company / organisation is predominantly responsible for funding through the apprenticeship levy.

2.2.2 UK Degree Apprenticeships

In November 2014 the UK government announced the development of a new form of vocational education i.e. degree apprenticeships (DA), which began delivery in autumn 2015 (BIS, 2014). Degree apprenticeships, which were first launched in the digital sector, combine academic learning and on-the-job practical training. They contribute to filling skills gaps in the economy and respond more closely to the needs of employers. Universities UK (2016b: 7) stated that:

> "Degree apprenticeships combine university study and workplace learning to enable apprentices to gain a full bachelor's or master's degree. An apprentice has full-time employment status rather than student status, and receives at least an apprentice's minimum wage."

Employer groups known as 'trailblazers' develop the apprentice standards which describe what an apprentice will do and the skills they will possess. The degrees are linked to professional standards identified by professional bodies or associations which make them relevant and credible to employers and apprentices. The Institute for Apprenticeships (2018) was created in April 2017 and is responsible for supporting and overseeing the development of apprenticeships.

Historically universities have been somewhat reluctant to become involved with lower level vocational education and training (Richard, 2012); however, a number of benefits for universities were identified (UUK, 2016b):

- Degree apprenticeships play an important role in Government policy.
- They provide a new income stream.
- DAs attract non-traditional students and widen participation.
- Encourage universities to diversify their full-time on-campus offering e.g. blended learning, distance, online, weekend.
- Degree apprentices will possess good skills and be attractive to employers.
- Links with employers can be developed.

In general, the degree apprenticeships are targeted at 18-19 year-olds providing an alternative route into higher education; however, they are also open to mature students. Furthermore, they support people from disadvantaged backgrounds for whom the cost of studying for a conventional degree is costly with fees in England being up to £9,250/year. The duration of study for a DA is 1 – 5 years and degree apprentices are not eligible for student loans.

Two thirds of the training costs and course fees of the degree apprenticeship are funded by government with a maximum cap, and the employer pays the other third. The employers also pay the apprentice a wage. This route towards a degree is advantageous to apprentices because not only do they receive a wage during their study they also do not have to pay university course fees (UUK, 2016c).

The degree apprenticeship applies to undergraduate degree levels 4 (certificate of higher education, Cert.HE), level 5 (diploma of higher education, DipHE), and level 6 (degree e.g. BA); and level 7, (master's degree e.g. MSc) (see Figure 1).

Apprenticeship Name	**Qualifications and Credit Framework (QCF) Level**						**Equivalent Education Level**
	2	3	4	5	6	7	
Degree Apprenticeship							Bachelors or Masters Degree
Higher Apprenticeship							Foundation Degree and above
Advanced Apprenticeship							2 Advanced-level passes
Intermediate Apprenticeship							5 GCSE passes , grades A*-C

Figure 1: Levels of Apprenticeship (Adapted from Universities UK, 2017)

In September 2015, the first places on degree apprenticeships were introduced in automotive engineering; banking relationship management; construction; and digital (UUK, 2016b). It was estimated that at least 60 universities and higher education institutions were intending to provide degree apprenticeships in 2017-18 (UUK, 2017) raising the number to 7,600 apprentices. The majority of apprentices are locally or regionally based indicating the relevance of providing training which is accessible and responsive to employers (UUK, 2017).

In May 2017, an Apprenticeship Levy of 0.5% was introduced for employers which had salary costs of £3m+. Employers who contribute to the levy can then recoup apprenticeship training costs from the fund. For organisations whose salary costs are less than £3m the government will pay up to 90% with the employer paying the additional 10%.

Assessment of the DA provision is provided by both HEFCE and Ofsted (Office for Standards in Education, Children's Services and Skills). Traditionally, universities have been assessed by HEFCE (Higher Education Funding Council for England) and the requirement for universities to respond to the demands by a different body (Ofsted) which is responsible for schools and further education colleges etc. has sometimes been onerous (Universities UK, 2017). So, how do these degree apprenticeships relate to the third mission and national industrial strategy? The next section will provide the context.

3.1 UK Government Industrial Strategy

For many years the UK government adopted a laissez-faire approach to the economy which involved limited intervention based on a belief that markets were best left to manage themselves (Mill, 1848). However, in 2016, a new Department for Business, Energy and Industrial Strategy was established which recognised the role of government in supporting industries and thereby enhancing the economy. Reflecting this new role, the government published '*Industrial Strategy: Building a Britain fit for the future*' (HMG, 2017) which, among other things, acknowledged the nation's world-renowned universities and the need to

translate their research into products and services which would support future growth and industries.

Five foundations of productivity were described in the Industrial Strategy: ideas, people, infrastructure, business environment, and places. In addition, four grand challenges were identified: placing the UK at the head of the artificial intelligence and data economy; becoming a world leader in mobility for people, goods and services; taking advantage of the movement towards clean energy; and, using innovation to support the requirements of an aging society. Among the key policies were the establishment of a world-class technical education system; increased investment in science, technology, engineering and maths (STEM) skills; and establishing a National Retraining Scheme to support people in changing jobs for digital and construction (HMG, 2017). To achieve all this the Strategy stated: "Business, academia, civil society and the government must engage together, bringing their expertise and entrepreneurial spirit, to drive us all towards success" (HMG 2017: 35).

The *Industrial Strategy* document described a number of examples of best practice including the University of Sheffield's Advanced Manufacturing Research Centre which will be discussed below.

3.2 Sheffield City Region Science Innovation Audit

The UK's levels of productivity have stagnated since the Great Financial Crisis of 2008 and have underperformed many other nations; furthermore, many regions of the UK including the Sheffield City Region have significantly lower levels of productivity than the South-East of England (ONS, 2018). This productivity deficit has been attributed to three main factors: structural readjustment arising from a movement away from manufacturing to activities with lower productivity; a skills shortage and relatively high levels of educational underachievement; and, lower levels of R&D and limited innovation and entrepreneurship (BEIS, 2016).

To address these challenges, the UK government stated, in 2015, its intention to conduct Science and Innovation Audits (SIA) to identify regional strengths, limitations and the potential opportunities for raising economic growth. Sheffield City Region Local Enterprise Partnership and Lancashire LEP formed a consortium to investigate their strengths in high value engineering and especially the potential to capitalise on Industry 4.0 i.e. the smart-factory which integrates artificial intelligence, manufacturing and the internet of things. Advanced Manufacturing Innovation Districts at both ends of the corridor linking the two regions of Sheffield and Lancashire are being developed which create innovative ecosystems.

The SIA identified four main areas of strength. Firstly, a strong higher education research base with growing income streams, Secondly, public sector R&D facilities e.g. National Nuclear Laboratory at Sellafield and large teaching hospitals – Sheffield City Region are involved with National Health System (NHS) Test Bed programmes. Thirdly, translational research centres which connect academia with regional and global companies e.g. AMRC Group with Boeing, McLaran, Rolls Royce, and Siemens. And, fourthly, private sector collaboration e.g. Siemens funding research at the University of Sheffield. Building on these strengths, growth opportunities were identified particularly in the area of Industry 4.0 and the 'internet of things' which integrate digital technology and manufacturing to increase

productivity and add value. Specific areas of market growth were identified in aerospace, nuclear energy, rail, and healthcare technology.

Drawing upon the opportunities identified, the Audit stated that:

> "The vision presented here is of a *"Northern Advanced Manufacturing Innovation Corridor",* bringing existing, emerging and new science and innovation assets and programmes into collaboration with industry to drive productivity growth in advanced manufacturing and key linked sectors across the region to world-class levels." (BEIS, 2016: 8).

To achieve this vision, the Audit conducted a gap analysis between the projected vision and the underlying skills and innovation base. It noted that general private sector R&D spend was low; the region's translational research institutions needed to be expanded to support industry; and academic research needed to be connected more strongly with local industry. There was particular concern around intermediate technical skills and attracting and retaining graduates (BEIS, 2016).

To bridge these gaps the SIA report recommended a number of steps: investment in science and innovation infrastructure; Northern innovation support; a Northern Powerhouse Productivity Academy in Lancashire; support for internationalisation; and support for talent attraction, development and retention. In addition, a pan-Northern skills programme will be developed to support the needs of advanced manufacturing and complementary sectors particularly for the skills required to support Industry 4.0. This approach is designed to encourage young people and thereby provide a talent pipeline to replace an aging workforce and retain skills in the North.

The Science Innovation Audit observed that if the region led the UK in implementing Industry 4.0 this would increase economic growth and productivity across the UK. In doing so it would contribute to the vision of a Northern Powerhouse: "…joining up the North's great towns, cities and counties, pooling their strengths, and tackling major barriers to productivity to unleash the full economic potential of the North" (HM Treasury, 2016). The area is being developed as the UK's Advanced Manufacturing Innovation District (AMID) and is designed to encourage innovation, inward investment, networking, production, research, and technology transfer.

3.3 University of Sheffield's Advanced Manufacturing Research Centre

The University of Sheffield's Advanced Manufacturing Research Centre with Boeing was founded in 2001 and has expanded to include two High Value Manufacturing Catapult Centres (AMRC, Nuclear AMRC); Medical AMRC; and the AMRC Training Centre. These are located in two centres located on the Sheffield – Rotherham border and they represent nearly £300m investment, have a turnover of £38m and employ more than 600 staff. It is situated in the Sheffield City Region Enterprise Zone and its mission is to assist manufacturers of all sizes to increase competitiveness through the use of advanced techniques, technologies and processes (AMRC 2018). As a result, it has attracted a range of companies to locate there including: a £110m Rolls-Royce Advanced Blade Casting Facility; a £50m manufacturing facility for McLaren supercars; and Boeing's first manufacturing plant outside North America. As a result of its success it has become a model for collaborative

research between universities, academics and industry which is being copied in Oman, South Korea and the United States (BEIS, 2016; AMRC, 2018).

Researchers are organised into core groups including: castings, composites, design and prototyping, integrated manufacturing, machining, Medical AMRC, metrology, National Metals Technology Centre, and structural testing. Researchers work on individual research projects for companies as well as collaborative research on generic research to support all members. The research supports a range of industrial sectors including: aerospace, automotive and transport, energy, food and drink, healthcare, infrastructure, and marine.

Companies can access the AMRC research and facilities through different levels of membership: Tier 1 costs £200,000 in cash or kind, and Tier 2 costs £30,000 in cash or kind. More than 100 companies have become members and the AMRC has a board containing industrial partners who have the opportunity to guide research direction.

3.4 The AMRC Training Centre

The AMRC was established to provide a sustainable manufacturing eco-system which includes skilled and knowledgeable employees to support operations. For this reason, the AMRC Training Centre was established to provide a range of training options including at apprenticeship, MBA and doctorate levels. In addition, it delivers bespoke training courses and a series of open continuing professional development (CPD) courses. The training facilities are constructed as a real manufacturing environment reflecting the apprentices' workplaces.

3.5 AMRC / University of Sheffield Degree Apprenticeships

Earlier in this chapter we discussed the historical progression of apprenticeships from the Medieval guilds to the recent development of degree apprenticeships in the UK. In particular, it was noted that, formerly, apprenticeships did not have the same status and respect which is found in other countries. To remedy this shortcoming, degree apprenticeships were developed by universities in liaison with employer groups known as 'trailblazers' which identify and specify the apprentice standards that describe what an apprentice will do and the skills they will possess. Linking the degrees to professional standards identified by professional bodies makes them relevant and credible to employers and apprentices.

All apprentices are employed full-time over a period from one to six years and work at least 30 hours / week. Training can be day-release or in blocks involving practical on-the-job training. University study is a key component of the degree apprenticeship programme. For example, the Level 7 Apprenticeship Standard for Post-graduate Engineer involves an industry led specification for Core Knowledge and Skills, and Core Behaviours which are detailed below:

Knowledge
the theoretical knowledge to solve problems in existing and emerging technologies, applying and developing analytical techniques
understanding of business and commercial needs/constraints

knowledge and understanding of own competencies capabilities and limitations, ability to work within these and highlight when work goes outside of these
understanding of financial responsibilities and authorisation processes
understanding of technical sign off responsibilities, who within their organisation needs to be involved in the sign off of product/processes

Skills
safe working practices, an understanding of technical governance and quality management
compliance with legislation and codes, but be able to seek improvements
practical competence to deliver innovative products and services
technical responsibility for complex engineering systems
accountability for project(s)/programme(s), finance and personnel management
management of trade-offs between technical and socio-economic factors

In addition to the Core Knowledge and Skills, post-graduate engineers need to possess Core Behaviours in the following areas:

A. Knowledge and understanding
B. Design and development of processes, systems, services and products
C. Responsibility, management or leadership
D. Communication and inter-personal skills
E. Professional commitment

3.6 Conclusion

This chapter has described how the Humboldt model of a university which focussed on teaching and research has been complemented with the third mission of connecting with businesses and communities through knowledge transfer, valorisation, engagement and training. This delivery of private training programmes by HEIs involves a wide and complex range of provision which is difficult to consider in detail. Moreover, definitions of training are not only narrow, they do not represent the broader considerations which are contained within the term ‘knowledge transfer’.

For the above reasons, the UK’s Industrial Strategy document was explored together with a Science Innovation Audit of Sheffield City Region. Regional strengths were identified in four main areas: a strong higher education research base; public sector R&D facilities; translational research centres; and, private sector collaboration. In particular, the University of Sheffield’s Advanced Manufacturing Research Centre was presented as a model for economic regeneration for other regions and which is also being replicated in Oman, South Korea and the United States.

A vision of a Northern Powerhouse across the north of England, and a “Northern Advanced Manufacturing Innovation Corridor” connecting centres of manufacturing excellence were described together with the gaps which needed to be overcome before the vision could be achieved. One of these gaps was the need for a more skilled workforce which would lead to higher productivity. To address this the government introduced a strategy to increase the reputation and number of apprentices which included the development of degree apprenticeships. The core knowledge, skills and behaviours of these DAs are identified by

industry representatives and then the DAs are delivered by universities with apprentices also learning in the workplace.

The University of Sheffield, along with many other civic universities, grew out of the University Extension movement during the late 19th and early 20th centuries and it was established by funding from local businesses and communities. This close association between the university businesses and communities has continued ever since and the impact of the University's AMRC is having a substantial impact not only on the local Sheffield City Region but nationally and internationally. The powerful triangular synergy of the third mission which exists between teaching, research and community should provide a sustainable platform for future economic growth and prosperity.

References

Abramovsky, L., Harrison, R., & Simpson, H. (2007). University research and the location of business R&D. *The Economic Journal*, *117*(519).

AMRC (2018) *Advanced Manufacturing Research Centre: A world-class centre for advanced manufacturing*, http://www.amrc.co.uk/files/document/103/1494864975_AMRCoverviewbrochure.pdf, accessed 17 April 2018.

BIS (2013) *The relationship between graduates and economic growth across countries, a report by NIESR*, London, BIS.

BIS, (2014) "New government and industry-backed digital qualifications will provide the skills for a wide range of digital jobs", https://www.gov.uk/government/news/new-qualifications-launched-to-meet-uk-demand-for-digital-skills, accessed 06.01.2018

Bruneel, J., d'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research policy*, *39*(7), pp. 858-868.

Chatterton, P., Goddard, J. (2000). The Response of Higher Education Institutions to Regional Needs. *European Journal of Education*, 35 (4), pp.475-479.

Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*, Boston, MA, Harvard Business Press.

D'Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?. *Research Policy*, *36*(9), 1295-1313.

De Montmorency, J. E. G. (1902). *State Intervention in English Education: a short history from the earliest times down to 1833*. University Press.

Department of Education and Science (1985) *The DES PICKUP Programme. Progress Report 1982-1985*, London, HMSO.

Department for Business, Energy and Industrial Strategy (2016). *Driving productivity growth through innovation in high value manufacturing: A Science and Innovation Audit report sponsored by the Department for Business, Energy and Industrial Strategy*, October, London, BEIS.

D'este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *The Journal of Technology Transfer*, *36*(3), 316-339.

Duale Hochschule Baden-Württemberg (2018). http://www.dhbw.de/english/dhbw/about-us.html, accessed 03.07.2018.

Duale Hochschule Latinoamericano (2018). http://www.dhla.org/, accessed 03.07.2018.

Eichinger, R., & Lombardo, M. (1996). The Career Architect Development Planner. Minneapolis, Lominger Limited.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, *29*(2), 109-123.

Fuller, A., & Unwin, L. (2003). Creating a modern apprenticeship: A critique of the UK's multi-sector, social inclusion approach. *Journal of Education and Work*, *16*(1), 5-25.

Geuna, A., & Muscio, A. (2009). The governance of university knowledge transfer: A critical review of the literature. *Minerva*, *47*(1), 93-114.

Goddard, J., & Puukka, J. (2008). The engagement of higher education institutions in regional development: An overview of the opportunities and challenges. *Higher education management and policy*, *20*(2), 11-41.

Graf, L. (2016). The rise of work-based academic education in Austria, Germany and Switzerland. *Journal of Vocational Education & Training*, *68*(1), 1-16.

HESA (2015) Higher Education - Business and Community Interaction (HE-BCI) survey 2013–14, https://www.hesa.ac.uk/data-and-analysis/publications/hebci-2013-14, accessed, 24 April 2018.

HM Inspectors (1990) *Pickup in Scotland: A Report by HM Inspectors of Schools*, March, Edinburgh, HMSO/Scottish Education Department.

HM Treasury (2016) *Northern Powerhouse Strategy*, London, HM Treasury.

Howells J.; Ramlogan R; and Cheng S (2012) Universities in an open innovation system: a UK perspective, *International Journal of Entrepreneurial Behaviour and Research*, 18 (4), 440–456

HM Government (2013) *The Future of Apprenticeships in England: Implementation Plan*, London, Department for Business, Innovation and Skills.

HM Government (2017) *Industrial Strategy: Building a Britain fit for the future*, London, TSO.

HM Inspectors (1990) Pickup in Scotland: A Report by HM Inspectors of Schools, Edinburgh, HMSO / Scottish Education department.

HM Treasury (2015) *Fixing the Foundations: Creating a more prosperous nation*, Cm 9098, London, HM Treasury.

Institute for Apprenticeships (2018) https://www.instituteforapprenticeships.org/ accessed 10.01.2018.

Kanter, R. M. (1994). Collaborative advantage. *Harvard Business Review*, *72*(4), 96-108.

Lambert, R. (2003) *Lambert Review of Business – University Collaboration*, London, HMSO.

Lockett, N., Kerr, R. and Robinson, S. (2008). Perspectives on the Challenges for Knowledge Transfer between Higher Education Institutions and Industry. *International Small Business Journal*.

Manpower Services Commission (1985) *A Glossary of Terms Used in Education and Training*, Sheffield, Training Division, MSC.

Mill, J. S. (1848) *Principles of Political Economy*, London, Longmans, Green and Co.

Office for National Statistics (2014) *Human Capital Estimates, 2013*: http://www.ons.gov.uk/ons/dcp171766_374868.pdf

Office for National Statistics, (2018) *International comparisons of UK productivity (ICP), first estimates: 2016*, London, https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/bulletins/internationalcomparisonsofproductivityfirstestimates/2016, accessed 10.01.2018.

Office of Science and Technology (OST) (2002) Investing in Innovation: a strategy for science, engineering and technology, London, HM Treasury.

OECD (2001) The Well-being of Nations: The role of human and social capital: Education and skills, Paris, OECD.

OECD (2015), *Preparing students for the future*, *Education Policy Outlook 2015: Making Reforms Happen*, Paris, OECD Publishing.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., & Krabel, S. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, *42*(2), 423-442.

Powell, J. J. W., and Solga, H. (2010). Analyzing the Nexus of Higher Education and Vocational Training in Europe: A Comparative-institutional Framework. *Studies in Higher Education* 35 (6), 705–721.

REF2014. (2011). "Assessment framework and guidance on submissions". Available from: http://www.ref.ac.uk/media/ref/content/pub/assessmentframeworkandguidanceonsubmissions/GOS%20including%20addendum.pdf

Reid, J. (2013) "Universities without walls: engaging our world", *Higher Education Review*, 46(1), pp. 31-51.

Richard, D. (2012) The Richard Review of Apprenticeships, London, School for Startups.

Schimank, U., & Winnes, M. (2000). Beyond Humboldt? The relationship between teaching and research in European university systems. *Science and public policy*, *27*(6), 397-408.

Toner, P. (2008). Survival and decline of the apprenticeship system in the Australian and UK construction industries. *British Journal of Industrial Relations*, *46*(3), 431-438.

Universities UK (2015) *The Funding Environment for Universities 2015: The Economic Role of UK Universities*, London, Universities UK.

Universities UK (2016a) *Higher Education in England: Provision, Skills and Graduates*, London, Universities UK.

Universities UK (2016b) *The Future Growth of Degree Apprenticeships*, London, Universities UK.

Universities UK (2016c) *University Funding Explained*, London, Universities UK.

Universities UK (2017) *Degree Apprenticeships: Realising Potential*, London, Universities UK.

Universities West Midlands (2018) www.universitieswm.co.uk, accessed 11.01.2018.

University of Sheffield (2017) *Foundation Degree in Mechanical Manufacture*: AMRC Training Centre, Sheffield, University of Sheffield.

Wilson, J. P. (2011) *The Routledge Encyclopaedia of UK Education, Training and Employment,* Milton Park, Routledge Falmer.

Wilson, J. P. (ed) (2012). "International human resource development", pp. 3-21, in J.P. Wilson, *International Human Resource Development: Learning, Education and Training for Nations, Organisations and Individuals*. Third Edition, London: Kogan Page.

Wilson, T. (2012) *A Review of Business–University Collaboration*, London, Department for Business, Innovation and Skills.

Winch, C., & Clarke, L. (2003) 'Front-loaded' Vocational Education versus Lifelong Learning. A Critique of Current UK Government Policy. *Oxford Review of Education*, *29*(2), 239-252.

Wolf, A. (2011) *Review of Vocational Education: The Wolf Report*, London.

Wolf, A. (2015) *Fixing a Broken Training System: The case for an apprenticeship levy*, London, Social Market Foundation.