

## Chapter 2

# Models of Interaction Between the Academy and Industry

**Abstract** Education has been accepted by the leaders of society as an overall public good and able to provide expertise to address difficult problems and produce solutions. Technical universities, or institutes of technology, had by definition a closer relationship to society since they were more concerned with the applied aspects of science and technology, which were of more immediate interest to those in society seeking to solve real-world problems. It is this latter aspect which has resulted in the widening agenda for the academy as a whole—in seeking to understand how it can play an effective role without diminishing its longstanding traditions of excellence in the core areas of teaching and research. In some cases this has been driven by government policy where the government provides some, or all, of the required financial support to the university. In other cases, it has been driven by financial necessity where there is little, or no, government financial support, and the institution has to generate its own income streams to support its mission and its teaching and research programmes. In a competitive market place and the increasing globalization of business, industry increasingly seeks to use strategies, tools and techniques that increase efficiency and effectiveness, whilst at the same time maximizing quality and minimizing cost. Companies may consider outsourcing their Research and Development requirements to reduce corporate overheads and optimize staffing levels. This means that Universities and other private laboratories can utilize the opportunity and look to collaborate with industry to supply this expertise on terms that are mutually acceptable and beneficial. Universities also generate their own spin-outs from intellectual property they create, as well as licensing technology to industry, rather than transferring it. However, the relationship between university and industry is not without its cultural differences and challenges, chief of which is the historical commitment of the academy to advance knowledge whether it is immediately applicable or not. In addition, there are many fundamental and important long-term research issues that many would argue are the primary duty of the academy to address, which may have no direct application in the short to medium term. This is resulting in increasing tensions in the academy, and in the priorities for national and international funding agencies. A variety of models of interaction between the academy and industry have been developed depending on the one hand on the circumstances of the institution, its

mission, its values, its expertise and its relationship to the local and cultural environment in which it is situated. On the other hand, there are factors to do with local and national industry including their needs and requirements, their methods of operation, and the degree to which the expertise in the academy may be utilized to advantage. The pros and cons of these various models are reviewed, and lessons learned are summarized.

**Keywords** Industrial collaboration • Marketization of the academy • Science and technology parks • Innovation • Intellectual property • Non-disclosure agreement • Knowledge-based economy • Knowledge transfer • Economic development • Blue-sky research

## 2.1 Introduction

National and international funding agencies generally support pure research via open and focussed calls for grant proposals which are evaluated by peer review. These have been an integral part of academy research for many years and are expected to lead to outputs including external publication in peer-reviewed journals and conferences, and patents.

Recent trends in the academy have been characterized by one or more of the following factors:

- Greater participation of students in many countries in higher education (rising from 5% of the population 50 years ago to over 50% today).
- Increasing marketization of higher education to more directly meet the needs of those who wish to utilize its services.
- The trend to top-down management models resulting in corporate universities where power and authority are transferred from faculty to managers and economic justifications dominate.
- An increasing environment of austerity due to national and international downturns in economies.
- The need to generate additional income streams in the academy to address funding shortfalls.
- The widening of the traditional academic role of faculty from research and teaching to also include collaboration with industry (e.g., [1]).

This has resulted in increasing attention being paid in the academy to the opportunities of interacting with industry, and exploring how effective collaboration to the benefit of both parties might be achieved.

Interaction with industry and knowledge transfer has already made considerable advances in many countries [2, 3], particularly those with well-established connections between academia and industry in the generation of world-leading products and services (e.g., Silicon Valley in the USA). As economies advance, it is

argued that they migrate from resource-based to knowledge-based production. Thus knowledge and innovation are two of the factors behind job creation and economic growth. This in turn affects the social context and also public and economic policy. Many national governments have therefore sought to address the challenges implicit in this observation and, in particular, provide motivation and incentives to increase the collaboration between industry and the academy in the expectation that there will be direct benefits to a nation's economy and overall global competitiveness. In turn, the academy has sought to address the challenges and opportunities where they align with their institutional mission. Clark [4] used the phrase “*entrepreneurial universities*” to characterize the aspects of promoting technology transfer within national systems of learning and innovation. Whether public or private, industry increasingly seeks to use tools and techniques that increase efficiency and effectiveness, whilst at the same time maximizing quality and minimizing cost. The current trend towards companies outsourcing their Research and Development (R&D) requirements to reduce corporate overheads and optimize staffing levels means that Universities can utilize the opportunity and bid to supply this expertise. Universities also generate their own spin-outs from intellectual property they create, as well as licensing technology to industry, rather than transferring it.

In addition, some countries that supply a proportion of the funding to their academies, and who see collaboration between academia and industry as an increasingly critical component of an efficient local, regional, and national innovation system, have sought to develop policies that seek to facilitate this, and to make a contribution to local, regional, and national economic growth and development.

Collaboration between universities and industries is critical for skills development (education and training), the generation, acquisition, and adoption of knowledge (innovation and technology transfer), and the promotion of entrepreneurship (start-ups and spin-offs). The benefits of university-industry linkages are wide-reaching: they can help coordinate R&D agendas and avoid duplications, stimulate additional private R&D investment (additionality effect), and exploit synergies and complementarities of scientific and technological capabilities. University-industry collaboration can also expand the relevance of research carried out in public institutions, foster the commercialization of public R&D outcomes, and increase the mobility of labor between public and private sectors [5].

## 2.2 Modes of Interaction Between the Academy and Industry

Industrial developments are generally supported by a number of possible approaches depending on the circumstances and those involved, and the perceived merits in the context of the objectives of the interaction.

Modes of interaction between the academy and industry can include the following.

- Consultancy—faculty member does external work for a company for which they are paid directly, though some institutions require a proportion to be given to the institution.
- Collaboration on an R&D project of mutual interest—where industry funds the R&D costs.
- Contract, or subcontract, from industry as part of an R&D project funded by industry, or by an external funding agency (e.g., EU, Fraunhofer, Innovate UK).
- Personnel exchange between the academy and industry.
- Setting up spin-off company—to generate product or service based on academy-owned Intellectual Property Rights (IPR).
- Licensing of academy-owned patents to industry.

These modes of operation are now analyzed in further detail.

### ***2.2.1 Consultancy***

Consultancy is normally under the direct control of the faculty though permissions may need to be sought from the institution on the time extent of the activity and also the ownership rights of any intellectual property that may be developed as part of the work. However, it does give the faculty member the opportunity to pursue areas of collaboration with industry in areas of their prime interests and where their research is at the leading edge. It also gives the companies involved the opportunity to outsource some of their R&D requirements to leading external authorities in the field without the overheads associated with setting up and maintaining an internal R&D section within the company. Also, in the development of a new product or service it may be difficult for the company to know in advance what R&D expertise will be optimum to further this goal. It thus becomes easier to buy in this expertise at the point that it is needed.

### ***2.2.2 Collaborative Research and Development***

Many institutions offer industry and government the opportunity to collaborate in areas of mutual interest and have set up frameworks, which define the rights and obligations of each party in the collaboration. It allows industry access to specialist expertise and also provides the academy with real-world experience in areas where a new product or service is a potential outcome of the collaboration. In addition, it allows the industrial partner(s) the opportunity to access specialist research expertise of the faculty in areas where some further investigations need to be done in leading-edge research areas before the project can be progressed (e.g., [6]).

Institutions have seen advantages in setting up Science and Technology Parks adjacent to the institution to act as a physical interface between the academy and

industry, and to provide support for collaboration and innovation. Such collaboration may be local where the partners can benefit from physical co-location, but they can also be national and international where the collaborations can utilize broadband network technology where appropriate. Such Science and Technology Parks may also provide a supportive environment where new companies can be launched [7, 8].

The Confederation of British Industry (CBI) indicated in 2015 that [9]:

More and more businesses of all sizes are benefiting from partnerships with universities for research, innovation, skills and professional development.

The CBI refers to Hefce figures which show that in the three academic years up to 2012-13, the amount businesses spent on contract research – where universities have a customer/contractor relationship with companies – at higher education institutions grew at an annual rate of more than 6% to over £440 m. Companies also spent increasing amounts on consultancy services, use of facilities and equipment, and training and professional development – investing £400 m in 2012-13 [10].

HEFCE produced a Business and Community Interaction survey for 2012–2013 [11]. The CBI and Pearson Education also did a survey and reported as follows [12, 13]:

A survey carried out by CBI and Pearson Education found that more than two thirds (70%) of the businesses had developed links of some kind with universities, while nearly half (48%) were looking to grow their university ties in the future.

Collaboration between the academy and industry may not always be straightforward due to the differences in culture and working practices between the two groups. The academy wishes to improve the standing of its research in terms of citations and league tables, whereas industry is focussed on its core business and maintaining its market share of products or services. Thus members of faculty are under pressure to work in areas of research that contribute directly to the esteem of the institution. However, the situation is changing due to a number of factors. These include:

- the trend to larger research collaborations with larger inter-institution grants, often in the leading institutions
- decline in research funding available due to economic constraints [for example UK research funding is below 0.5% of Gross Domestic Product (GDP)] [14]
- more directed forms of research, such as those concentrating on addressing what are perceived as “Grand Challenges” [15]
- perceived uncertainties about the future of UK collaborations within the European Union (EU).

The leading institutions, therefore, take a larger share of grant funding, which in turn forces other institutions to look at other options, including the local growth agenda and the application of knowledge to address local challenges and problems.

### **2.2.3 *Contract or Sub-contract***

Contracts from industry, funding agencies, or government may be allocated to academies in order to perform pieces of work or supply particular services. They may also be allocated to individuals within academies.

Larger projects funded by the European Union offer the opportunity for the academy and industry to collaborate with partners in other European Countries. Normally the evaluation of proposals is based on scientific excellence, industrial leadership, and the degree to which the proposal addresses key societal challenges. Successful grant proposals lead to a contract with the consortium to produce an agreed set of deliverables over a specific timescale, typically 3–5 years.

The recent decision by the UK to exit the EU has resulted in some uncertainty about how such collaborations involving the UK might proceed in the future. The UK government has already agreed to fund the UK cost for any proposals already approved, and it is envisaged that such funding would continue after the formal exit has been accomplished by 2018. Currently, Swiss partners participate in EU proposals and projects with their funding being paid automatically by the Swiss government.

The following report summarizes how the UK has performed in its relationship to EU funding since 2007 [16]:

Headline facts from UK research and the European Union: The role of the EU in funding UK research include:

- The UK is one of the largest recipients of research funding in the EU. UK scientists have earned more back in EU research grants (€8.8 bn, 2007 – 2013) than, analyses suggest, it has contributed to EU research expenditure (indicative figure of €5.4bn, 2007 – 2013, reported by the ONS).
- The UK Government funds 30% of research and development undertaken in the UK, whilst the EU funds around 3%.
- The UK is second only to Germany in terms of Framework Programme funding received (this is funding allocated competitively). If structural funds that are targeted at building research capacity in less economically developed regions of the EU are also taken into account, it is fourth.
- The UK's world-class research talent is highly successful in securing much sought after EU European Research Council and Marie Skłodowska-Curie fellowships that are awarded on the basis of excellence – receiving just over a fifth and a quarter of the total budget respectively for these programmes.
- EU funding represents an increasing proportion of research income for UK universities. Over the last five years, universities have seen their total research income rise thanks to a combination of EU and private sector funding. This is despite experiencing a drop in UK government funding over the same period.

### **2.2.4 *Personnel Exchange***

Exchanges between the academy and industry are supported by the Royal Academy of Engineering in the UK. It provided support for early to mid-career academics to

spend 6–12 months in industry, and also visiting professorships to allow leaders from industry to work in academia [17, 18].

### ***2.2.5 Spin-off Companies***

Faculty can initiate spin-off companies with the support for facilitators inside or outside the University. They may belong to the person(s) who own the Intellectual Property Rights (IPR) and patents on any systems, products, or processes associated with the company. The University may own a percentage of the company—depending on the framework established within the institution.

### ***2.2.6 Licensing***

An institution may own some patents it does not wish exploit directly as it does not have the required infrastructure to do so without further investment of funds. If an external company is interested to utilize the patent(s) it may be possible to enter into a licensing arrangement with the institution for an agreed period.

These various models of operation may be summarised in Table 2.1.

## **2.3 Evaluation of the Pros and Cons of the Different Approaches**

The pros and cons of the different approaches may be briefly summarized as follows:

The many types of university-industry links have different objectives, scopes, and institutional arrangements (see Table 2.2). Collaboration may be more or less intense and may focus on training or research activities. Collaboration may be formal or informal, from formal equity partnerships, contracts, research projects, patent licensing, and so on, to human capital mobility, publications, and interactions in conferences and expert groups, among others [19]. Also it is useful to differentiate between short-term and long-term collaboration. Short-term collaborations generally consist of on-demand problem solving with predefined results and tend to be articulated through contract research, consulting, and licensing. Long-term collaborations are associated with joint projects and public-private partnerships (including private-funded university institutes or chairs, joint university-industry research centers, and research consortia), often allowing firms to contract for a core set of services and to periodically re-contract for specific deliverables in a flexible manner. Longer term collaborations are more strategic and open-ended, providing a multifaceted platform where firms can develop a stronger innovative capacity in the long run, building upon the capabilities, methods, and tools of universities [20, 21].

**Table 2.1** Comparison of potential Aspects and Issues of the Models of Operation

| Model                   | Ease of Setup                                                                    | Timescale          | Overhead                                                                                   | Potential Issues                                                                                       | Open Publication?                               |
|-------------------------|----------------------------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Consultancy             | Dependent on faculty and institution                                             | Variable           | Institution may require a percentage                                                       | Reward model within the institution                                                                    | Generally no                                    |
| Collaborative R&D       | Needs strong interest of both partners                                           | Variable           | May be none                                                                                | EU projects required a minimum of 3 partners<br>Dealing with IPR generated by a project                | Yes                                             |
| Contract or subcontract | Needs convergence of interests and expertise                                     | Variable           | May be none                                                                                |                                                                                                        | Yes, by permission of the contractor            |
| Personnel exchange      | Needs convergence of interests and availability of suitable people for the roles | Typically one year | May be none                                                                                |                                                                                                        | Yes                                             |
| Spin-off company        | Will require legal and administrative guidance                                   | Variable           | Institution may take a share of any subsequent sale, if written into the contract at setup | Takes time and effort, and generally employs its own staff—with faculty member remaining as an adviser | May be subject to nondisclosure                 |
| Licensing               | Will require legal and administrative guidance                                   | Variable           | Institution may take a share of any revenue generated if it is part-owner of the patent(s) |                                                                                                        | Will need permission of the user of the license |

The three university missions have given rise to the distinct concepts of teaching university, research university, and entrepreneurial university. University-industry collaboration may take place under all of these university regimes, although it will have a distinct focus on training in the teaching university, on R&D in the research university, and on technology commercialization and spin-offs in the entrepreneurial university. In any case, complementarities exist among the different university-industry links. For example, agreements to develop joint research may give rise to opportunities for training doctoral students. Likewise, collaboration in research may lead to the creation of spin-off companies or to the licensing of patents [23].

**Table 2.2** A typology of university–industry links, from higher to lower intensity

| Intensity of relationship | Components of the collaboration            | Description of the components of the collaboration                                                                                                                                                 |
|---------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High (relationships)      | Research partnerships                      | Interorganizational arrangements for pursuing collaborative R&D, including research consortia and joint projects                                                                                   |
|                           | Research services                          | Research-related activities commissioned to universities by industrial clients, including contract research, consulting, quality control, testing, certification, and prototype development        |
|                           | Shared infrastructure                      | Use of university labs and equipment by firms, business incubators, and technology parks located within universities                                                                               |
| Medium (mobility)         | Academic entrepreneurship                  | Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own (spin-off companies)                                                     |
|                           | Human resource training and transfer       | Training of industry employees, internship programs, postgraduate training in industry, secondments to industry of university faculty and research staff, adjunct faculty of industry participants |
| Low (transfer)            | Commercialization of intellectual property | Transfer of university-generated IP (such as patents) to firms (e.g., via licensing)                                                                                                               |
|                           | Scientific publications                    | Use of codified scientific knowledge within industry                                                                                                                                               |
|                           | Informal interaction                       | Formation of social relationships (e.g., conferences, meetings, social networks)                                                                                                                   |

Source Adapted from Perkmann and Walsh [22], Tables 2 and 3

Table 2.3 illustrates how the priorities for university–industry partnerships can be affected by the particular stage in the academic and economic development of the university.

### 2.4 Challenges, Cultural and Social Issues Between the Academy and Industry

The following issues may characterize differences at the interface between the academy and industry, and highlight the ongoing issues which can affect the degree to which a collaboration between the academy and industry is able to progress and be successful.

**Table 2.3** Priorities for university–industry partnerships at different stages of economic development along the three missions of universities

| Mission of University      | Most developed countries                                                                                                                      | Least developed countries                                                                                                                                                                                  |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Teaching University        | <ul style="list-style-type: none"> <li>• Private participation in graduate programs</li> <li>• Joint supervision of Ph.D. students</li> </ul> | <ul style="list-style-type: none"> <li>• Curricula development to improve undergraduate and graduate studies</li> <li>• Student internships</li> </ul>                                                     |
| Research University        | <ul style="list-style-type: none"> <li>• Research consortia and long-term research partnerships to conduct frontier research</li> </ul>       | <ul style="list-style-type: none"> <li>• Building absorptive capacity to adopt and diffuse already existing technologies</li> <li>• Focus on appropriate technologies to respond to local needs</li> </ul> |
| Entrepreneurial University | <ul style="list-style-type: none"> <li>• Spin-off companies, patent licensing</li> <li>• Entrepreneurship education</li> </ul>                | <ul style="list-style-type: none"> <li>• Business incubation services</li> <li>• Entrepreneurship education</li> </ul>                                                                                     |

Source [24]

### 2.4.1 Timescale

The academy normally operates on a longer timescale than industry. Historically, research projects in the academy have lasted for up to three years or more. Larger, inter-University projects may last up to five years. Industry on the other hand is often in a competitive situation in the market place and needs to deliver products and services on a much shorter timescale in order to maintain its position. There can also be tensions between short-term technological progress and longer term research on what are regarded as the more important fundamental questions (called “Grand Challenges” in some disciplines).

### 2.4.2 Reward Model

The academy reward model has traditionally been based principally on the delivery of new research results, which have been published in peer-reviewed journals and conferences. The results have therefore been assessed by national and international experts in the field against the current state of the art. In recent years some universities have widened these criteria to include excellence in teaching and collaboration with industry. However in the latter area, the extent and merit of the work done can be difficult to evaluate if it is subject to confidentiality agreements and non-disclosure. In addition, where it is able to be evaluated, there is currently no generally accepted scale of excellence against which it may be measured and evaluated (except perhaps in the area of patents). This can introduce uncertainty in assessing the value of what has been achieved.

### ***2.4.3 Value of Applied Research***

Historically, the academy has regarded pure research as of a higher value than applied research, and regarded the latter as more concerned with development or implementation rather than seeking to discover something fundamentally new. However, this is also slowly changing over time. The academy is increasingly recognizing that often pure and applied research go hand in hand, particularly in engineering and medical areas [25].

### ***2.4.4 Technology Transfer Culture***

Some institutions have a long history of working with industry and have a strong entrepreneurial culture. They have been able to provide avenues of opportunity for undergraduates and graduates to obtain employment with companies with whom the academy has strong links and associations. However, this can cause some undergraduates to leave before completing their course. This can benefit industry, but may not be in the long-term interests of the individual.

### ***2.4.5 Communication and Values***

Communication and decision-making in the academy has been historically collegiate in nature and based on an informal consensus within the faculty. The faculty determines the overall academic direction of the institution. On the other hand, industry is often more hierarchical and may require the formal approval by senior management of any decisions that are made. Thus, there can be considerably more freedom and flexibility within the academy to change direction relatively quickly, if this should be required. This may be more difficult to accomplish in industry. There can also be differences in the stated values of the respective organizations which can give rise to misunderstanding. However, there are current trends toward an increasing degree of management and control within the academy in order to meet the strategic priorities as determined by its mission. This can enable the academy to align more closely to the needs and requirements of industry.

### ***2.4.6 Differences Across Discipline Areas***

Disciplines in the applied sciences lend themselves more naturally to exploitation by industry because they are closer to industrial products and services. On the other hand, subjects in the liberal arts and the humanities may appear to be more distant,

and consequently less applicable. This asymmetry between disciplines can create tension in the academy when its mission includes technology transfer or improvement of society in general. The academy can give different internal priorities to its various academic disciplines with corresponding financial and budgetary implications. However, such divisions are often not clear-cut as many companies employ arts graduates in various roles, including in the humanizing of technology, and producing products and services which are adaptable and easy to use. In addition, the creative industries offer opportunities for interdisciplinary collaborations between technology and the arts.

#### ***2.4.7 Economic Impact***

Impact factors have been incorporated into research grant proposals and the periodic audit of research quality in the UK. This has been opposed by key academics in the UK. More than 18,000 academics, including six Nobel Prize Winners, have written to the UK government to condemn the current plans to include economic impact in the evaluation of research.

The scholars are concerned that making university research more accountable to the wider economy will stifle the sort of curiosity-driven research that has led to groundbreaking discoveries and Nobel prizes”.

History shows us that in many cases it is basic research, undertaken purely out of curiosity to understand more about our world, that has delivered revolutionary breakthroughs, “Dr Kirby-Harris said.” X-rays, lasers and semiconductors – technologies widely used in every aspect of our lives – all stem from discoveries made through fundamental research, undertaken without any immediate application in mind.

Sir Tim Hunt, one of six Nobel Prize winners to sign the petition, said: “The impact guidelines will discourage academics from making discoveries and will encourage people to come up with unoriginal research proposals. The whole idea of research is to find out things you didn’t know before. The fruits of basic research are unpredictable and to seek to control them in this way is not in the interests of the country [26, 27].

#### ***2.4.8 Diversification of Academic Mission***

The academy supports the principal areas of teaching, research, knowledge transfer, and widening access. Some concentration of mission might have been expected according to the history of an institution and its strengths, but the external environment can also have an influence. For example, institutions that have extensive research grants and do best in the delivery of research results, generally have the best potential for collaboration with industry. They have the best infrastructure and are able to provide the best support for these collaborations. Lesser institutions can end up by being squeezed out of both research and knowledge transfer. Thus

diversity of mission can be as much affected by merit and attractiveness to the market place as by internal choice.

Further detail on these issues and the potential differences between the academy and industry can be found in [2].

### ***2.4.9 Intellectual Property Agreements***

Intellectual property agreements need to be carefully drafted in order to avoid potential future problems. There needs to be a clear and unequivocal understanding on both sides of what the agreement is and the entitlements of the partners in the agreement. Clearly they need to be considered well in advance of the production of any patents.

## **2.5 Lessons Learned**

The tensions that a number of faculties have felt between basic research and working with industry is not easy to resolve and is likely to continue. Historically the academy has been more concerned with blue-sky research, i.e., scientific research in areas where real-world applications are not necessarily apparent. In addition, where applied research is performed, there has always been a tendency in the academy to regard it as of lesser value (or even of no value) compared to basic research. It has been characterized as “development” or “implementation” and not regarded as research. The periodic research audits that are performed (e.g., in the UK via the REF) need to ensure that the evaluation of applied research and outcomes of academy–industry collaborations do full justice to the work that has been done, and do not regard it as a lesser achievement simply because it is more difficult (for commercial and confidentiality reasons) to secure open literature publications in internationally leading journals (and which can count up to 60% in the overall evaluation).

The trend toward increasing contact with industry along with increasing direction by the university executive was not universally accepted by academia. For example, the Congregations of the universities of Oxford and Cambridge voted against proposals for increasing the managerialism in their institutions in 2006. It was regarded as a threat to the traditional autonomy within their colleges [28]. The academy was not against reform per se, but was of the view this was better handled by academic leadership within the colleges and with due regard for their academic freedom, democracy, and independence, rather than the executive and/or trustees of the university. The primary issue, therefore, was to decide the form of governance which would best serve the interests of the university and those of the faculty, bearing in mind their historical traditions. Nevertheless both Oxford and Cambridge have developed strong collaborations with industry in areas of mutual interest both

before and after the debates on the optimal form of governance within the institution. Thus these collaborations were not intrinsically dependent on the form of governance that was chosen. However, clearly large amounts of time and resource were spent on the debate which appeared to lead directly, or indirectly, to the resignation of the Chief Executive Officer of Oxford (the Vice chancellor). With the benefit of hindsight this can have done little to maintain morale or reduce the tension between management and faculty over issues such as this. However, Oxford was ranked first in the global league table position of universities in 2016 [29], so it has not affected its overall reputation and standing as an institution, and may have enhanced it.

## 2.6 Conclusions

Models of interaction between the academy and industry have been reviewed. Different models may be appropriate for the particular mission of an academy, and the different phases of development of academies over time. Local and national governments are seeking to influence the contributions that universities may be able to make to local and national economies in the areas of economic growth and the development of new products and services.

The following is an extract from “Making industry-university partnerships work—Lessons from successful collaborations” [30]:

Long-term strategic partnerships between universities and industry that run for 5 to 10 years are the most productive at driving innovation, according to a study published by the Science/Business Innovation Board AISBL, a not-for-profit scientific association create to improve the climate for innovation in Europe.

Universities and industry have been collaborating for over a century, but the rise of a global knowledge economy has intensified the need for strategic partnerships that go beyond the traditional funding of discrete research projects.

World-class research universities are at the forefront of pioneering such partnerships. They are designed to run longer, invest more, look farther ahead and hone the competitiveness of companies, universities and regions.

In short, they transform the role of the research university for the 21st century, anchoring it as a vital center of competence to help tackle social challenges and drive economic growth.

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