

Towards Revitalizing Welsh Manufacturing: The Role of Welsh Universities

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Abstract This paper discusses the need for, and benefits for both parties from, collaborative research projects between industry and academia developing a case study from the ASTUTE project which develops such projects between universities and manufacturing businesses in Wales.

We discuss the history of engagement between academia and industry, and of manufacturing in Wales, then develop the case study of engagement through ASTUTE, with details of ASTUTE's achievements and findings from academic and business partners in three of ASTUTE's projects. We conclude that ASTUTE has achieved some success by providing value to both the university and businesses.

1. Introduction

In the ever competitive and rapidly globalising world, the Welsh Government has sought to elevate and establish the region as a knowledge economy, where "production and services are based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence" (Powell and Snellman, 2004).

The makings of a knowledge economy are however, often hinged on the ability of regions to develop systems of production and consumption that are based on intellectual capacity (IC). This concept of IC, which enables an accelerated pace of technical and scientific advance (Powell and Snellman, 2004), has traditionally been in the forefront of 'must haves' for organizations, especially as earlier research adopted a firm level approach. However, research on how regions benefit from high levels of IC has also been studied and in so doing, Stahl and Bounfour (2008) suggest that "the intellectual capital of a nation includes the hidden values of individuals, enterprises, institutions, communities and regions that are the current and potential sources for wealth creation".

Due to this fact that the foundations for the knowledge economy and IC emphasize the development first of all, of individuals, followed by enterprises, institutions and so on, universities have emerged as pivotal actors expected to play active roles in its promotion. Huggins and Kitagawa (2009) for example, suggest that in many regions, universities are considered the core of the knowledge base and at the heart of the knowledge economy, acting as key elements of innovation systems, supporting science and innovation-based regional growth while Kelly et al (2002) indicate that economic development and the welfare of regions can be enhanced through universities' engagement with the local economy through research, education, industry-university partnerships and technological innovation.

The dynamics of university-industry (UI) relationships therefore, is an issue that has attracted considerable attention in academic literature. Early empirical studies for example, Roy (1972) while commenting on the “very weak coupling” between universities and industry in the US suggested that the field of UI interaction needs to be actively developed and further suggested a taxonomy of methods of UI scientific and technical interaction. Linnett (1971) also suggested that closer relationships between industrial and university research in Britain would be to the mutual benefit of both parties. He also offered his classification of methods of UI interaction. More recently however, the research in UI relationships has developed extensively. Although not an aim of this paper, a cursory look at the literature by the researchers was conducted and in summary, some of the areas of UI relationships included and were categorised into: Innovation and entrepreneurship (Dooley and Kirk, 2007), sustainability (Wells et al, 2009; Ramos, 2009), and regional development (Bramwell and Wolfe, 2008; Ramos-Vielba et al, 2010)

2. Background: Setting the Scene

2.1 History of Manufacturing in Wales

Manufacturing has been and continues to be critical to the success of the Welsh economy. Historically, a dominant feature of the Welsh economy was the reliance on the coal and steel industry. Between 1800 and 1900, the population quadrupled due to the iron-making and coal production which attracted people and industry to the valleys (Hill, 2000). Between 1920 and 1999 however, amidst several high and low periods between those years, employment in those sectors reduced from over 300,000 to just 2000 and the devastation was compounded by a lack of diversity in employment opportunities (Jones, 2000)

Following these incidences, Wales had to make the transition from the heavy dependence on coal and steel to a more diversified economy based on manufacturing and more recently, services (Morgan, 2007). Unable to draw on the resources of a robust indigenous business class, this modernization of the Welsh economy was led by government incentivised attraction of manufacturing investment from foreign owned multinationals from the US, Europe and Japan (Morgan, 2007). The 1970s thus saw Wales lead the way in recognising the potential benefits of inward investments and between 1979 and 1991, foreign investment in Wales accounted for over 14% of the UK total (Welsh Affairs Committee, 2012). Empirical evidence suggested that this success in attracting inward investments into Wales was as a result of low unit labour costs, good road infrastructure and access to government funds and financing (Hill and Munday, 1994). With the coming of globalisation and the pressures on firms to stay competitive in the new world market however, the environment for attracting foreign investments into Wales changed rapidly. According to Evans et al (2008), “...Wales lost large proportions of its foreign manufacturing employment and output”. Inward investments and the jobs created from it began to fall and between 1998 and 2008, 171 foreign-owned sites closed in Wales, with a loss of 31,000 jobs mainly in manufacturing (Welsh Affairs Committee, 2012)

Recent years however have witnessed a re-awakening of the spirit captured during the boom years of foreign investment. This time the Welsh Government aims to develop strategies to transform the economy of Wales through more high quality inward and home grown investments. According to Rhodri Morgan AM (Welsh Assembly Government, 2002), the strategy is to increase the knowledge, research, development and innovation capacity in all parts of the Welsh economy and build on the considerable strengths in manufacturing, among other things. The report goes on further to state that the Government will, “work to increase existing collaboration between universities and colleges and companies in Wales”

2.2 Academic Activities in Wales

After identifying the key drivers towards business growth as innovation, entrepreneurship, skills, investment and trade, WAG (2005) stated that “targeted measures in these areas are complemented by the education system in improving average skill levels and making further progress towards an innovative, knowledge-based economy”. They mention further that “this is seen most clearly in the roles of our higher education institutions in carrying out cutting edge scientific and other research, working with businesses to exploit this research commercially and providing a strong supply of highly skilled people”

It has however been suggested by scholars that with the abundance of scholarly facilities and practitioners in Wales, there is no adequate or equal engagement between these scholars, industry and policy makers. Huggins and Kitagawa (2009) argue that universities often target large scale industrial research projects rather than provide services for SMEs in their localities who they consider to be non-cost effective in comparison to working with large firms. Morgan (2002) also states that the higher education in Wales has been prevented, hitherto, from playing a full role in solving the major problems endemic to the Welsh economy. He attributed this to the structure of the sector as well as its funding arrangements. Wells et al (2009) have also argued that although individual academics may have been involved with industry in a fragmented manner it is hardly an example of a framework of engagement or cohesive use of the world class expertise available for the region.

With such admonishing remarks, more recent developments have witnessed a focus on developing cohesive engagement frameworks to harness this world class expertise. For example, the European Commission (2011) published a guide aimed at assisting the Managing Authorities of the European Regional Development Fund (ERDF) improve the contribution of universities to regional development. One of these development projects is the subject of this submission and is highlighted below.

3. Advanced Sustainable Manufacturing Technologies, ASTUTE

ASTUTE is a £27 million project, with a total of £14 million coming from the Convergence funding of the ERDF through the Welsh European Funding Office (WEFO). This follows the identification of parts of Wales as convergence regions; regions within the EU that have “a low level of investment, a higher than average

unemployment rate, lack of services for businesses and individuals and poor basic infrastructure, among others” (Puigcerver-Penalver, 2007).

Specifically, the aim of ASTUTE is to enable the manufacturing industry in West Wales and the Valleys to grow by adopting more advanced technologies, and at the same time improve its sustainability by reducing its environmental impact. Led by Swansea University, this will be achieved by a partnership of universities throughout Wales that will harness the engineering and management related expertise within them for the benefit of the economic prosperity of the Convergence Region. The objectives set for the project were defined in line with the need to meet the challenges of manufacturing growth and sustainability. These objectives are to assist 350 enterprises, conduct 40 collaborative R&D projects, create 5 new enterprises, create 120 jobs and enable an investment induced of £4,000,000. Other objectives are to promote environmental sustainability with at least 16 companies adopting or improving their environmental management systems, enable the intellectual property registration of at least 40 products, processes or services and enable the launch of at least 120 new products, processes or services. These objectives were divided among the universities, leaving them to develop their own strategies as to how they approached companies within their region for collaborative partnerships based upon common reporting methodologies.

Being CU Project Officers, this submission is therefore Cardiff specific, highlighting the experience of the authors in collaboration with industry.

3.1 Achievements and Challenges

CU ASTUTE staff sought to engage with potential partners through personal contacts, referrals from these personal contacts, business fora, and some targeted cold calling. What we found was that most companies were initially, apprehensive about entering into any collaborative R&D partnership with the ASTUTE project even when this assistance was ‘at no cost’ i.e. already paid for by the funding from WEFO. Findings revealed that this apprehension was due to (i) past experiences, where universities only wanted to collect data for research purposes, without any contribution to the company operations. (ii) an uncertainty about what the universities had to offer in terms of real practical and/or commercially viable knowledge and (iii) no previous collaborative experience or contact with universities

Table 1: CU Achievements (as at June 2013 – approximately half-way through the project)

| Targets | Overall Targets | Achievement so far |
|--------------------------------------|------------------------|---------------------------|
| Enterprise Assisted | 90 | 79 |
| Collaborative R&D | 10.3 | 39 |
| Jobs Created | 33.4 | 6.5 |
| Enterprise Created | 1.3 | 1 |
| Investment Induced (£) | 1,028,000 | 236,953 |
| New or improved products | 30.8 | 129 |
| Products, processes, services | 10.3 | 2 |

There were some companies however, that needed very little encouragement to engage with the ASTUTE project. Findings revealed that these companies were (i) mostly high value or advanced manufacturing enterprises that had had previous collaborative engagements with universities (see **Table 2** for the technology project areas the CU ASTUTE team participated in) (ii) employers of highly skilled and educated staff who sought to adopt new technologies and ways of working into their operations (iii) either facing retrenchment, re-organisation or closure and welcomed assistance that would enable them to maintain business momentum

For the companies that entered into collaborative R&D partnerships with the CU ASTUTE team, the achievements so far are shown in **Table 1**. Findings revealed that most of the companies went on to further develop second and sometimes, third collaborative projects with the ASTUTE team. This in itself was a testament to the high value resources (people + equipment) the universities are able to put to practical use for the benefit of industry and the Welsh economy.

Table 2: Collaborative Engagements by Technology Area

| Technology Area | Enterprise Assists | Collaborative R&D |
|-------------------------------|--------------------|-------------------|
| Product Design and Innovation | 23.9 | 7.2 |
| Computational Modelling | 1.7 | 2.5 |
| Rapid Prototyping | 5.7 | 1.3 |
| Electronics/Photonics | 4.6 | 2.4 |
| Software | 4.2 | 0.9 |
| Materials | 5.5 | 1.8 |
| Process Routes | 11.4 | 6.2 |
| Process Modelling | 2.5 | 4.3 |
| Destructive Testing | 0.2 | 0.4 |
| Non Destructive Testing | 3.2 | 2.8 |
| Recycling Technology | 0.3 | 0.3 |
| Logistics/Supply Chain | 8.7 | 3.7 |
| Robotics/Automated Systems | 1.7 | 1.2 |
| Additive Manufacturing | 0.3 | 0.2 |
| Lean Manufacturing | 5.3 | 3.8 |
| TOTAL | 79 | 39 |

4. Methodology and Research Design

A multiple case study methodology was adopted to investigate the experiences of both university and industry staff during engagement activities. This appeared to be the most valid approach for capturing in-depth experiences to explain the benefits to universities and industry of collaborative research projects through ASTUTE. Both unstructured and semi structured interviews were conducted with 5 senior members of staff from the 3 case study companies (see **Table 3**). Four academic staff from CU who were involved with company interactions through ASTUTE were also interviewed. Each set of respondents had three initial questions to answer as well as three proposed hypotheses to discuss.

For the academics, the following three questions were asked:

- What is your history of interaction with companies?
- What interactions with companies have you had through ASTUTE?
- Have you gained, or do you expect to gain any research benefit from working with ASTUTE through ongoing projects?

For the companies, the following three questions were asked:

- What is your experience of working with HEIs?
- How does this compare to working with ASTUTE?
- How do these compare to working with consultants, if you have done so?

Based on the development of case studies A and C, we developed three hypotheses about the way that ASTUTE works with academia and industry. We presented these hypotheses to the academic interviewees and the industrial interviewee at the final case study company (company C) for comment:

- ASTUTE is a Gateway/Gatekeeper/Matchmaker
- ASTUTE is a Translator
- ASTUTE is not a consultancy/about fundamental research, but is adding value to some companies

During and after the discussions surrounding these questions, both the interviewers and interviewees were free to include follow up questions which may have shed more light on the topics of discussion.

5. Company Case Studies

Company A: This is a large SME that currently employs just under 250 employees.

ASTUTE engaged with them on a 3 month pilot project with the aim of understanding how SMEs engage with process improvement techniques. This company launched their process improvement initiative two years prior to their project with ASTUTE, having gained funding to engage a consultant to carry out staff training in process improvement; following this they wished to gain a better understanding of how they, as an SME, should start to put process improvement tools and methods into practice. They needed some extra support and mentoring during this learning period as no one in the company had any prior experience of such implementations in practice, and ASTUTE was able to guide and assist them in this process, thus gaining valuable research insights into their engagement.

Following on from this project, ASTUTE arranged a meeting between company representatives and CU academic staff, to discuss options for further support, including student projects (one of these has been completed, supervised by academic 1, and provided great benefit for the company and a valuable experience for the student), applying for a KTP (this is currently underway with academics 1 & 2, who attended the meeting); Executive education at CU (the company may be interested in this at a future date) and potential further support from ASTUTE, for a

whole-company project to investigate how they initiate, sustain and audit process improvement activity

Table 3: Case Studies and Company Interviews

| Company Identification | No. of people interviewed | Interviewee's position within company |
|------------------------|---------------------------|---|
| Company A | 2 | R&D Manager Design Engineer |
| Company B | 1 | General Manager |
| Company C | 2 | Engineering Manager Operations Manager |

Company B: This company is a small SME with less than 100 employees. Key technical challenges are their wide product range combined with very short lead times.

The company is currently engaged with ASTUTE on their first project, again looking at how SMEs engage with process improvement techniques. The scope for this project has changed somewhat as the company had initially specified requirements to investigate rationalizing some product and process designs as well as the introduction of a new process to bring in-house a process step which has previously been out-sourced. This new process is currently on hold pending cost-benefit analysis while some of the design work has been completed in-house. Simultaneously a new employee has begun some process improvement work which led the company to wish to investigate further possible benefits from carrying out process improvement throughout the plant. Company B's collaborative research project will now focus on understanding how changeovers affect their perception of inventory required for different products, and (as for company A) how they should initiate, sustain and review their process improvement activities.

Company B have a longer initial project ongoing, and are currently working with 3 academics to specify a student project following the academic's visit with ASTUTE.

Company C: Although this company is part of a corporation headquartered in the USA, their Welsh operation operates as an independent entity. Their UK operation currently employs just over 100 people.

Company C was looking to review their factory shop floor layout in order to free up extra capacity. The company had some experience with process improvement but the strategy for this had been determined by senior managers; they sought support from ASTUTE to investigate ways to begin to devolve strategic planning of improvement to middle managers. To achieve these two aims, ASTUTE worked with the company on a mapping exercise involving middle managers and supervisors in understanding the current state and business needs in order to gain consensus on a current state. This was achieved, even though supervisors had previously been quite resistant to plans which might involve changes in their areas such as loss of floor space, and it was felt that this was largely due to their enhanced ability to see "the big picture".

Company C was pleased with the outcome of the workshops and signified their interest in working with ASTUTE again. They also signified their interest in a further university – industry engagement through the KTP programme. The data gathered (e.g. observations and interviews) will further inform research into how SME-sized businesses engage with process improvement.

6. Academic background

Table 4 sets out a summary of the academic staff members' responses to the interview questions relating to their experience and background. It can be seen that all of these interviewees had extensive experience of working with companies both in and outside of academia

All except one expected to gain some research or teaching benefits from interaction with ASTUTE (the one exception to this reflected the initial belief that ASTUTE officers were not to carry out any research).

7. Results - Hypotheses

Responses to the hypotheses were as follows:

7.1 ASTUTE is a Gateway/Gatekeeper/Matchmaker

All the academic respondents agreed with this general hypothesis, although their views on whether this was necessary varied – one felt that it was unnecessary, and universities should not be acting to sort out problems for companies. At the other end of the spectrum, one felt that projects like ASTUTE were required for SMEs who were struggling with resources. A further academic respondent commented that there was scope for ASTUTE to grow within this role, harnessing further opportunities in academia and in industry.

We supplemented this hypothesis with several sub-hypotheses as follows. Three of the academic staff agreed with the sub-hypothesis that it could be hard to make initial contacts with companies, although they felt that once links were established there was no problem with building the relationship; there was a null response from the fourth academic staff as he was not asked this question. The second sub-hypothesis for hypothesis 1 was that ASTUTE projects generated better understanding of company needs and comparison to university offerings / university research needs and matching to company situations and interests.

Table 4: Summary of Academic Interviews

| | Academic Position | Experience working with companies | Involvement with ASTUTE projects | Expectation of benefit |
|---|-------------------|---|--|--|
| 1 | Lecturer | Worked outside academia for a company for 2 years. Current academic research is applied and must involve industry | 1 project – student placement and involved in KTP application, following on from project with Company A | Expect to gain access to companies and information about their requirements. |
| 2 | Senior Lecturer | Worked for companies, quantitative data gathering with companies | 1 project – involved in KTP application following on from project with Company A | Yes (reason for engaging with ASTUTE) |
| 3 | Lecturer | Worked for a number of companies outside academia in various capacities (temp, student, permanent). Current academic research is applied and must include industrial relationships (for example, 10 week secondment to industry during a project) | 2 projects – involved in scoping for a project which did not proceed. Further involvement in current project with Company B | Data for academic publications, practical and real life case studies for teaching purposes, student projects |
| 4 | Professor | Extensive international work experience with large companies during whole academic career. Current authority in global automotive industry | 1 company approach – company declined the project. Also, considered that this company, or many others in Wales for that matter, cannot utilize my skills and knowledge | No. ASTUTE cannot generate remuneration or research findings |

The same three academic interviewees responded to this statement – one agreed and one agreed with the proviso that it depended on the duration of the interaction, as longer interactions were more beneficial to the academic staff member, the third commented that companies were often not sufficiently aware of their own? long term needs and so ASTUTE help in this respect would necessarily be limited.

Summary: ASTUTE does act as a gateway or matchmaker and can be of help to some academic staff in forging new relationships to companies and, where there is sufficient duration of interaction with ASTUTE, in passing information about company and university needs and offers/possibilities.

7.2 ASTUTE is a Translator

The researchers' experience is that company representatives are often wary of academics as they fear that neither side will understand the other, and further, that academia and industry work on different timescales and again, neither tends to understand the other. One of the company respondents pointed out that ASTUTE in particular had helped to translate material in books relating to process improvement, so that he could see how it applied to his business. The academics tentatively agreed that ASTUTE aided in linguistic translation, but in general felt that they themselves were able to communicate with companies (possibly because they all had experience of working with industrial partners). One of them pointed out that ASTUTE might also assist with translating fundamental research for the applied setting.

Summary: ASTUTE may act as a translator in terms of language used and in terms of translation of research to suit a particular setting.

7.3 ASTUTE is not a consultancy or about fundamental research but is adding value to some companies

The two company representatives asked about this both felt that ASTUTE was very different to the consultants they had worked with. One commented that consultants tend to have preconceived ideas (linked to the Unique Selling Point or USP of their consultancy) on how to deal with a particular problem, and/or tended to try to sell him the idea that they thought he wanted. The other described the relationship as if the company is walking blindfold through a maze full of unknown obstacles; the consultancy will lead the company safely through the maze avoiding the obstacles and the company can try to replicate it, but will not necessarily understand why they took that route or what obstacles they avoided in doing so. ASTUTE, on the other hand, they likened to an external observer who discusses the obstacles and suggests methods from academic theory for avoiding them, then observes the company's responses. Neither of the company interviewees commented on the fundamental research angle, possibly because they do not distinguish between fundamental and applied research.

Of the four academics, two agreed that ASTUTE neither carried out fundamental research nor consultancy; ASTUTE's aim is different to consultancies' aim. Both

these respondents were clear that there was benefit to both companies that engage (one said that they learn by doing and ASTUTE encourages them to become self-sufficient, which compares to the response from the company respondent linked to this academic interviewee's project, and one said that ASTUTE helps companies make significant changes and adds value to companies that engage). The other two academics were less certain about this statement as they believed that there was a false distinction between academics and consultants, or that the term consultancy should be further defined or clarified (this latter respondent however also stated that ASTUTE sat somewhere between blue sky thinking and commercial application).

Summary: ASTUTE is adding value to the companies that engage and is helping them to become more self-sufficient in application of the ideas presented; a difference can be identified between ASTUTE and both fundamental research and consultancy.

8. Discussion and Conclusion

Our background research suggests that manufacturing is seen as an important sector in Wales, which has suffered during difficult times economically but is enjoying a growth in support due to renewed understanding of its importance; further, that R&D and academic support has not hitherto been sufficient to support manufacturing, but ASTUTE aims to improve on this previous performance.

The results so far from ASTUTE show that it has made good progress towards its goals and this paper has set out to understand how it has interacted with industry and academia by acting in some senses as a gateway and a translator and added value to both; we have explained how:

- the university has benefitted from development of student projects, bids for Knowledge Transfer Partnership funding, and gathering of in-depth qualitative research data,
- academic partners feel that they already engage with industry but that ASTUTE provides some benefit in introducing new partner companies
- Industrial partners have "learnt by doing", benefitting from translation of research and a different kind of support than they would achieve from consultants.

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Further information on ASTUTE can be found at www.astutewales.com