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Briefing: Negotiating value at the research-practice interface in the water sector

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One researcher, two guvnors: Negotiating academic and practitioner value in the water sector

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Abstract

Lessons from our experiences of managing an Engineering Doctorate (EngD) programme are delineated in this document with particular emphasis on the relationship between research and practice. We report on applied (practice oriented) research at the UK's Industrial Doctoral Centre (IDC) for the Water Sector. A descriptive account of negotiating value at the research – praxis interface is presented based on decades of collective practice during which we have seen the EngD model mature and grow. Conclusions focus on recommendations pertaining to project management, knowledge transfer and the effective and consistent translation of academic and practitioner project details.

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Introduction

Theoretical advancement and practical applicability can be divergent targets of research projects. In engineering, the interface between industry-led applied research and knowledge-creation by research is increasingly generating interest, demand and value. Although research-based instructional strategies to improve education in STEM (Science, Technology, Engineering and Mathematics) subjects have had mixed success and are not always easy to implement, adopt or scale-up in education systems (Borrego and Henderson, in press), there has been increasing interest in models which couple industry driven research with professional skills acquisition.

In 2009, the UK Engineering and Physical Sciences Research Council (EPSRC) established a number of Industrial Doctorate Centres (IDCs) to operate at this interface between industry and academia. The IDC model supports trans-sector cohesion in research and skills acquisition. The STREAM programme is one of these EPSRC funded IDCs, providing industry-led post-graduate training for the water sector (see www.stream-idc.net). The STREAM programme is delivered by five UK academic centres of excellence in water science and engineering; Cranfield University (the coordinating institution), Imperial College London and the universities of Sheffield, Newcastle, and Exeter. STREAM is run in collaboration with the water industry (utilities, equipment suppliers, consultants etc.) to develop industry-driven but also academically challenging research projects that allow researchers to develop their skills and careers while obtaining an Engineering Doctorate (EngD) degree.

The programme of research and learning offered through the STREAM IDC is informed by contemporary developments in both post-graduate training theory (Barnacle and Dall'Alba, 2011) and higher education programmes for water and sustainability (Missingham and McIntosh, 2013). The syllabus is aligned with the transferable skills priorities advanced by the Engineering Council's UK Standard for Professional Engineering Competence (EC, 2013). This skill set, coupled with industry driven and academically supervised doctoral research projects, is arguably more likely to achieve the desired improvements in STEM skills (Dales and Arlett, 2008) than if the engineers were to either receive 'in-house' training from industry alone or embark on a traditional doctoral research programme.

In the following sections we draw out lessons from our experiences of managing an Engineering Doctorate programme with particular emphasis on the central relationship between academia and industry.

One researcher, two guvnors

The approach to post-graduate research and training detailed above necessarily exposes our Research Engineers to both academic and industrial working environments; two settings which they are expected to be able to work equally effectively in. Working norms are very different in

academia and industry, as are the types of behaviour that are valued and the typical modes of communication. Consequently, Research Engineers need to develop a nuanced skill sets that enables them to deliver quality outputs to different audiences.

Research Engineers studying for an EngD find themselves in a strange and often challenging situation. Their work is sponsored by one type of organisation (a commercial company) whilst their ability to secure the award they seek is moderated by a completely different type of entity: a university. Furthermore, their research is overseen by both an academic and an industrial supervisor, imposing a potential divergence in priorities. There will be areas where goals are well or largely aligned and, if managed sensitively and progressively, this triangle of ambition has huge potential to shape successful outcomes for all parties. There will also, however, be times and circumstances where priorities come into conflict and trade-offs are needed. Such instances are typically restricted to time or resource constrained conditions, although personality clashes can often catalyse disputes over research design and dissemination priorities.

In addition to pursuing their own aspirations through an EngD programme, the Research Engineer is the primary resource through which the goals of the other two stakeholders are delivered. Life at this delivery apex can consequently be fraught and bewildering. At worst, where supervisors are not communicating between themselves, Research Engineers can be subject to competing requests for action and deliverables and conflicting expectations about quality and progress. This can become tiresome and ultimately affect the progress of the project. Simply ensuring that supervisory teams are aware of these hazards and understand what actions they can take to both prevent such situations occurring and minimize the detrimental impact if they do has been seen as helpful. We also note that the consistency of supervisory appointees is closely correlated with successful projects.

So how can such situations be managed so that all parties can exploit the potential benefits of the EngD model? Our experiences suggest that it is the academic supervisor who should take ultimate responsibility for both the quality of the relationships and the clarity of communication between the partners. Both differences in emphasis and congruencies between the academic and industrial agendas for the project should be transparent and open to discussion. Guidance and support for the Research Engineer should be offered with a united voice – even if this means separate bilateral discussions between the supervisors. Industrial supervisors should also be encouraged to play an active role in the Research Engineer's professional development. Finally, both supervisors need to be acutely aware of and sensitive to the very real difficulties that a Research Engineer faces in trying to operate effectively in both an academic and industrial environment.

Such pro-active management of the project, including regular trilateral meetings where progress is monitored and, crucially, expectations for upcoming activities are agreed, are essential for two reasons. Firstly because applied (practice oriented) research is perhaps more frequently subject to changes of ambition or focus than pure research and such changes in course need to be reviewed, agreed, and incorporated into the overall project plan. Secondly, it is on these occasions that the value of the research for each stakeholder is, either explicitly or implicitly, articulated and negotiated.

Negotiating value

As noted above, there is a natural inconsistency in ambitions between the various stakeholders in an EngD project. We have seen how this manifests itself in terms of the Research Engineer's experience but it also extends to and influences the research project itself. EngD research, as a process, is rarely shaped by the vision of a single individual. It is more commonly the negotiated outcome of a learning process through which the Research Engineer, academic supervisor and industry supervisor explore the limits of their own ideas, beliefs, and preferences.

Projects need to possess an appropriate balance of academically and industrially relevant content if they are to enjoy equally passionate commitment from both sides of the collaborative fence. This parity of engagement is also important if the Research Engineer is to benefit from the synergies that come from having access to multiple sources of expertise. Box 1 contains descriptions of three current STREAM projects, providing an illustration of the types of research being undertaken through the programme.

Box 1: Specimen STREAM projects

Improving the Performance of Plastic Joints in Water Distribution Systems (Severn Trent Water, WRc and the University of Sheffield)

Although polyethelene pipes are a favoured option for distribution network renewal amongst the water companies, their electrofusion-welded joints can fail prematurely if best practice installation principles are not followed on site. The main causes of such failures are pipe scraping, misalignments and contamination. Using an experimental rig retrofitted to an existing servo-hydraulic fatigue-testing machine, electrofusion fittings are cyclically pressurised with a controlled element of joint contamination. These tests have characterised the relationship between joint failure and the dynamic pressures experienced in water distribution systems and identified those aspects of installation practice where poor workmanship impacts asset integrity.

Hydrogen production from wastewater using Microbial Electrolysis Cells (Northumbrian Water and Newcastle University)

The production of Hydrogen using Microbial Electrolysis Cells (MECs) has long been recognised as having potential as an alternative energy source. MECs that utilise the organic compounds present in municipal wastewater as a feedstock for the bacteria in the cell hold promise but have only been demonstrated at laboratory scale. By analysing the challenges of technology scale up and performance under operational conditions, this project brings academic rigour to the process of technology development. Early evidence from the trials suggests that the operational performance of MECs with real wastes at ambient temperatures and larger scales is not well predicted by the warm temperature, acetate fed small-scale systems used in most fuel cell research.

Algae reactors for wastewater treatment (Anglian Water, Severn Trent Water, Scottish Water and Cranfield University)

Impending regulation will impose tighter limits on the discharge of phosphorus from wastewater treatment works with current methods of phosphorus removal looking unlikely to be suitable options due to either operational or economic considerations. The use of immobilised microalgae, which assimilate both phosphorus and nitrogen during their growth, offers a novel alternative process that has low energy requirements. Laboratory scale experiments have demonstrated that the immobilised microalgae can remediate phosphorus to below 0.2 mg L^{-1} at retention times of 6 to 12 hours. Additional benefits include the remediation of ammonium and nitrate and an increase in biogas production, offering the promise of an energy neutral or energy positive process.

All three of these projects illustrate the strong association of scientific understanding with industrial and commercial value that exemplifies EngD research. The uniting of academic thoroughness and industrial pragmatism spawns authoritative and useable knowledge. However, the intellectual and practical insights generated through such research will be ascribed stakeholder specific value; value which may be incommensurate across research outputs and which may be driven by immediate concerns that intrude into and delay the achievement of longer term ambitions. The various values of research outputs therefore need to be aligned towards such a universally advantageous outcome. Exploring the ways in which different stakeholders can value a single output should be a central concern of the trilateral progress meetings described above.

Our experiences indicate that, although the academic supervisor is initially more pro-active in balancing out value, Research Engineers take an increasingly active role as their understanding of the EngD process matures and they develop confidence in their own ability to shape the direction of their work. One of the developmental indicators that supervisors of post-graduate research students look for is the adoption by the student of project, and eventually intellectual ownership of the work. It is at this emancipatory juncture in the EngD process that Research

Engineers feel not only confident enough in their own understandings but also sanctioned by their peers (supervisors) to take a more active role in attributing and negotiating the value of their work.

Conclusions

Our recent experiences of operating an EngD programme lead us to three broad conclusions regarding what makes for effective management of the interface between research and practice. The first of these pertains to project management. Because the vast majority of research to practice processes involves professionals from both sides of the spectrum, there is an inherent tension between often incommensurate organisational priorities and working practices. Consequently, close monitoring of the association between project goals / outputs and how the various contributors will value these is needed.

The second inference that can be drawn from our work is that it is those operating at the delivery apex must develop the knowledge transfer skills needed to effectively bridge the research – practice gap. The skill sets required to excel at this role are not acquired easily or quickly. Many of the competencies are only developed through repeated experiences and, as there are few useful support resources, learning on the job is the primary training measure. Patience is an increasingly rare commodity in contemporary professional life but in this context it is, we argue, invaluable.

Finally, we would draw attention to an analogy that we frequently use to help our Research Engineers better understand the role they are being asked to engage with. By viewing activities at the research – practice interface as requiring constant translation in order to be effective, we can start to ask sensible questions about what aptitudes we might need in order to improve the flow of knowledge. As an intermediary, Research Engineers find themselves regularly providing explanation, clarification, illustration, interpretation etc. for their colleagues who are less familiar with the academic or practitioner details of a project. Such translation and mediation services are invariably required in both directions. Without them, poor quality communication (through nobody's fault) constrains or prevents understanding and without understanding progress is permanently shackled. Richard Saul Wurman, one of the founders of the TED conferences, once,said: 'As you learn about something try to remember what it is like not to know' (Wurman, 1990: 130). Working at the research – practice interface is a constant reminder of this maxim; one that EngD graduates are perhaps better placed than most to make use of.

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