The use of feasibility study funding to develop an independent research strategy

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Abstract

Developing an independent research strategy is a key objective for many postdoctoral research staff. However since many such individuals are reliant on external funding which is often difficult to secure at that particular grade, this is frequently a difficult transition to achieve. In this paper the case for using feasibility study funding to achieve this will be presented based on the author's personal experience of such a study.

Introduction

Obtaining a postdoctoral research position is the logical and, in the UK, most common (Hodges et al 2008) step for PhD graduates who wish to pursue a career in academia. Such positions are often reliant on external funding and are often focussed on a single project. While postdoctoral research staff are often encouraged to engage in teaching this is often limited by time constraints and other commitments. For many postdoctoral researchers who wish to remain in academia the next logical career step is to secure a permanent lecturing post. In addition to teaching, however this requires the development of an independent research portfolio. This is a difficult transition for many potential academics to make since many funding bodies prohibit or limit the eligibility of contract researchers to apply for external funding. Furthermore the requirements of working on externally funded research contracts often makes it difficult for postdoctoral research staff to obtain the necessary teaching experience, particularly when attempting to move away from delivering learning materials developed by others.

Feasibility study projects offer postdoctoral researchers the opportunity to address many of these issues and improve their prospects for obtaining permanent employment. In this paper such a project is described in terms of how it supported the transition from supervised contract research to independent research.

Introduction to Project

The institute for Automotive and manufacturing Advanced Practice (AMAP)at the University of Sunderland, UK (AMAP 2013) has been active in research, training and consultancy for over 20 years. Current focus areas include advanced maintenance, incorporating work on maintenance strategy development, condition monitoring and asset management, and Electric Vehicle Technology. Traditionally these areas have been the focus of separate research activity with some common staffing. However over the past two years, a number of projects have been developed which focus on both activity areas.

One such recent example was a feasibility study conducted by the author to investigate Electric Vehicle Through-Life Management based on Telematic Data. The study was funded by the UK National Centre for Through-Life Engineering Services at Cranfield University (TES 2013), which if funded by the Engineering and Physical Sciences Research Council (EPSRC). As part of the Centre's activity it invited proposals for feasibility studies to look at new areas for the application of 'through-life engineering services', to include topics such as advanced maintenance management, condition monitoring and asset management techniques.

The feasibility study which was successfully proposed by the author aimed to investigate the role of telematic monitoring systems in the management of Electric Vehicles (EVs). EVs have become widely recognised as being a viable alternative to conventional Internal Combustion Engine (ICE) powered vehicles. This is due to recent advances in battery technology which has allowed vehicle range to reach an acceptable level for many users. Despite such advances availability and range of vehicles remains a substantial concern for many. Alongside concerns regarding the range of EVs between charges are issues around the lifespan of several key components, most notably batteries, and the overall reliability of the vehicles. Such uncertainty can lead to risk adverse behaviour in potential early adopters and ultimately impair the uptake of EVs. Vehicle fleet operators have been identified as potential early adopters for this technology and as such it is critical that the lifespan and reliability of these assets is managed effectively based on proven asset management methodologies.

Reliability management and maintenance strategies for conventional vehicles have developed over recent decades. The run to fail ethos has been replaced with a mixture of approaches which encompass aspects of planned preventive maintenance and condition based maintenance using diagnostic tools and data gathering in systems including engine management systems. Such approaches have matured alongside the addition of sophisticated control systems which allow this data to be collected. Electric Vehicles by their nature make use of state-of-the art on board systems for gathering, processing and communicating data including power flow, speed and acceleration as well as position gathered from GPS systems. The application of such systems is, at present, largely confined to tracking the location of vehicles and monitoring the performance of batteries.

The hypothesis which underpinned the project was that such

data has potential to underpin the development a new maintenance and reliability paradigm for the automotive industry where maintenance patterns are managed on an individual basis for each vehicle based on its previous usage patterns, maintenance records and reliability/condition data.

The detailed objectives for the work were to:

- Identify the major components in battery-electric drive trains.
- Identify the frequently occurring failure modes and assess their impact on vehicle operation
- Identify the data currently collected from telemetry systems
- Network with UK ULCV manufacturing community
- Network with UK ULCV early adopters
- Network with UK telematic system providers.
- Develop a roadmap for the development of new solutions to apply asset management techniques to maximise ULCV lifespan.

In order to investigate the issues described above a two pronged strategy was utilised:

1. Direct contact has been made with a number or organisations who have been involved with the development or use of ULCVs in some fashion. Discussions with these organisations have taken place via email, telephone and face to face meetings. These organisations have been broadly categorised as:

    - ULCV Manufactures
    - ULCV Component Manufacturers
    - ULCV Users
    - Infrastructure Operators
    - Telematics Providers.

2. An extensive review of the literature has been carried out on certain key technological areas. This has allowed state of the art research to be investigated before it reaches a level of technical readiness which brings it to the attention of vehicle manufacturers.

Based on the data collected by these means a gap analysis was performed and a roadmap for future development in the sector has been developed. The following have been identified as outcomes needed if EVs and similar Ultra Low Carbon Vehicles (ULCVs) are to achieve successful uptake:

- **Streamlined Maintenance Management using Telematic Data** The reduced number of moving parts means that the maintenance activities required for EVs is greatly reduced. This reduction has the potential to increase the inefficiencies inherent in scheduled maintenance as performed on conventional vehicles. This is a particular problem given the scarcity of EV support facilities. The application of condition based maintenance will reduce the demand on these facilities maximising their availability and reducing cost.
- **Improved management of vehicle economics including management of battery replacement.** One of the most substantial barriers to EV uptake is uncertainty regarding the life expectancy of EV batteries. Furthermore the second hand value of batteries is currently not adequately understood. This uncertainty means that EV ownership is seen as high risk, which impacts upon leasing and other costs. Additionally the introduction of lightweight materials for producing vehicle chassis and body work is likely to change the economics of vehicle scrapping and recycling compared with the use of metals which are subject to corrosion.
- **Management of Battery lifecycle economics.** Battery costs are seen by many as the most critical aspect of EV lifecycle costs. However the costs associated with battery use depend not only on their use and life in a vehicular application but on any second life use which they can be subjected to and on recycling cost at the end of their life.
- **Development of intrinsically reliable ancillary power systems.** One of the major reliability issues for EVs has been the failure of the ancillary power systems meaning control systems fail to operate. This simple fault has had an impact on operator confidence in many instances. Furthermore many ancillary systems present substantial power drains on limited power reserves reducing vehicle range.
- **Development of Reliable EV braking systems.** Current EV braking systems utilise friction brake systems from equivalent sizes of ICE vehicles. Such systems are prone to extremely light use in certain usage patterns and as such are prone to accelerated degradation increasing running costs.

At the time of writing a major grant proposal is being prepared to address some of these issues in collaboration with academic and industrial partners identified during the feasibility study process.

Feasibility Study Attributes

In the following paragraphs the various attributes of the feasibility study project described above will be discussed in terms of the benefits the author experienced from a career development perspective.

Networking. A key part of the methodology described above

was interaction with other academics and industrial figures working in related sectors. A total of 28 organisations were contact, of which 18 engaged in the study in some fashion representing a positive response rate of 64%. Engagement ranged from email discussions to face to face meetings, facilitated by the travel budget allocated to the project. Some of the participants were existing AMAP contacts who the author had not previously interacted with personally and seven of the participating organisations had previously not engaged with AMAP in any capacity at all.

Exposure to/working with industry. A number of the organisations who participated in the study were industrial in nature. This provided the author not only with valuable industrial contacts but also with a range of view points on the current state of the art and the industry's view on future research and development needs in this sector.

Developing familiarity with the literature. The in-depth study of battery technology allowed the author to engage with the literature in this area in an extremely detailed fashion. Through the literature review which was carried out it was possible examine battery technology within a range of application sectors broadening the scope of this part of the project while increasing the detail.

Identifying niches and opportunities. The engagement with a relatively large number of organisations with diverse interests in the topic of the study led to the suggestions of a wide range of gaps in current research. Each of these had to be carefully considered in terms of technological realism and the likelihood of securing funding. Furthermore it was necessary to look beyond the responses given and identify potential future directions which had not yet been envisaged. In order to achieve this the Technology Readiness Level (TRL) descriptors prepared by the Automotive Council (Automotive Council 2011) was used to underpin the individual evaluation of the various research directions and opportunities identified.

Developing new funding streams. As a consequence of the project a substantial funding proposal is now being produced which will focus on some of the issues identified for future attention. Future proposal are also envisaged based on this work. Furthermore as part of the study the author was able to attend information days for several national funding schemes in the area described.

Developing research led teaching. Research-led teaching is a priority for many higher education institutions, with dissertations and final year projects being one of the dominant opportunities to engage taught-course students in research-related activities. In addition to identifying potential large scale, externally funded research projects, the study also identified a number of smaller projects which are potentially suitable for final year projects for both undergraduate and postgraduate taught-course students.

Conclusions

Developing an independent research direction, research-led teaching and industrial contacts and awareness are major hurdles for many postdoctoral researchers looking to secure a permanent academic position. The feasibility study described in this paper provided the author with an invaluable opportunity to address these gaps in his own career. It is the author's view that the study, which came to an end in March 2013, played a key part in helping him secure a permanent academic post shortly after completion.

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