

Institution: Liverpool John Moores University
Unit of Assessment: 15
a. Context

Research in the General Engineering Research Institute (GERI) focuses around two interacting areas; manufacturing processes and measurement/inspection. The main user groups that are beneficiaries of our research outputs are:

- Multi-national manufacturing industry.
- The regional SME manufacturing community.
- The international health technology development and user community.
- The remote sensing user community.

Multi-National Manufacturing Industry.

During this assessment period GERI has impacted upon a number of major manufacturers including; Rolls-Royce, GETRAG-Ford, Shell, GKN, PTG-Holroyd & Cinetic-Landis.

In the case of manufacturing processes we;

- Develop new processes such as High Efficiency Deep Grinding (HEDG) and vibro-HEDG, (with Rolls Royce). The university is currently working to commercialise this technology.
- Improve existing processes in terms of cost and efficiency, such as multiplexing lasers to machine in parallel, or improve fluid delivery in grinding, (with Cinetic-Landis).
- Make processes both more economic and environmentally friendlier, such as investigating Minimum Quantity Lubrication in grinding, (with Holroyd).
- Take traditional processes to new levels of applicability, such as understanding new modes of vibratory mass finishing, (with Potters Ballotini Ltd).

In the case of measurement and inspection technology we;

- Create new techniques such as new unwrapping algorithms that enhance speed, applicability and robustness of optical measurement systems, (with for example Shell).
- Create innovative new instruments, such as our low-cost absolute interferometry devices.
- Develop new modes of ultra-sound imaging for the detection of early states of failure in electronic assemblies (with Delphi Electronics).

The Regional SME Manufacturing Community.

GERI runs ERDF projects engaging SME's as R&D partners. These projects provide both resources and mechanisms through which the Institute can successfully transfer knowledge and capability. Details of how these initiatives operate are presented in section (b).

The Health Technology Community.

Our main impacts in this sphere have been related to instrumentation and include;

- The development of new systems for the measurement and monitoring of patient position during radiotherapy, (with Christie Hospital).
- The creation of international networks of practitioners to guide technological developments in cancer treatment, (the ECSON Network).
- The international adoption of our phase-unwrapping algorithms in MRI and neuro-imaging.

The Remote Sensing Community.

The take-up of our phase unwrapping algorithms (developed initially by us for use in optical metrology) by developers of Synthetic Aperture Radar (SAR) enabled satellites (EADS-Astrium) and users of seismic data analysis systems, (Shell).

b. Approach to impact

GERI's approach to impact is "multi-stranded" with an additional preparedness to exploit any opportunities that may arise outside of our strategy. The main strands of the core strategy are;

1. Special projects designed to specifically drive impact.
2. Innovative ways of disseminating our work.
3. Managing external relationships.
4. Placing our PhD graduates inside companies.

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1. Special Projects Designed to Drive Impact.

GERI is located in a region where economic regeneration is a priority. This is challenge, but it is also an opportunity in that it makes ERDF monies available for projects that contribute to wealth creation. Since 1992 GERI has had six such projects, each reinforcing our commitment to working alongside and supporting industry. During the course of this assessment period GERI has run two of these projects, namely the 'Engineering Development Centre' (EDC) and 'The GERI Research Outreach Project' as described below. One of the benefits of these projects is the contractual requirement to be impactful according to metrics such as; new jobs created, jobs safeguarded, increase in company turnover and Net Value Added (NVA). This requirement acts as a significant driver to produce, and evidence for external auditors, that the research work done in collaboration with the companies has indeed had a tangible and measurable impact.

ERDF also funds additional personnel to support impact, a full-time 'industrial liaison engineer' and a project administrator. The former ensures successful engagement and effective knowledge transfer; the latter provides client relationship management, a key aspect of our approach.

An important element of our strategy is wide and effective dissemination of our activities to both large companies and SME's. ERDF funding gives us the resources to commission displays and literature and to organise events for industrialists specifically aimed at building links and contacts. For example a recent promotional event saw over 100 companies from the North West attend a "GERI Lab Open Day", viewing our facilities and exploring collaborative research opportunities.

These projects also resource our engagement with important facilitators, such as relevant KTN's, enabling us to play an active role within them; and organisations such as our local LEP, with whom we have a particularly strong and mutually supportive relationship.

The Engineering Development Centre: This project, completed within this assessment period, was staffed by six R&D engineers, most of whom were GERI PhD graduates. Over its lifetime it resulted in; 167 companies assisted, the creation of 59 new jobs and the safeguarding of 60 jobs, a turnover growth of £4.9M and a resulting increase in NVA to the companies assisted of £6.2M.

Two examples of some of the many projects undertaken include:

1. Try&Lilly Ltd., identified image processing as a technology to improve quality control. This involved accurate high-speed measurement of cloth patterns etc. Protective materials were also investigated, enabling a major order to be received in 2011, securing the company's future, creating 1 new job and the saving of 10 jobs in a workforce of 60.
2. dB Research Ltd., were assisted in the design and test of the world's first marine "Black Box". This included signal processing, compression and storage of data. Assistance was also given in both engineering and in EMC testing to meet maritime regulations. Launched in 2010 the device is now available as the Broadgate VER 4000 from Senex ES Ltd.

The GERI Research Outreach Project: As this project is not due to complete until 2015 final stage outputs, such as jobs and NVA-added, are not yet known. However so far, 32 companies have been assisted (target 47) to secure >£1.6M in external funding to enhance their R&D activities. As a result the regional R&D base, and critically its research capability, is being significantly strengthened.

Again we can give a flavour of the nature of the interactions via two examples:

1. Biomer Technology Ltd. is an SME with an interest in polymer coatings for cardiovascular stents. They identified structuring of polymer coatings as a key technology to develop for their future growth. GERI commenced an EPSRC grant in collaboration with them in 2012.
2. Performance Springs Ltd. is an SME supplying high performance springs used in fuel injection and valve applications. A collaborative TSB feasibility study was secured in 2013 to research and improve the spring chamfering operation.

It is in the nature of these ERDF interventions that each individual company result may be modest, but taken across the whole project they amount to impact on a significant scale.

2. Innovative Methods of Dissemination.

GERI seeks to be pro-active in grasping externally generated impact opportunities. One example is our promotion of our phase-unwrapping work. In 2010 we made our algorithms available for free download. This was a successful strategy leading to wide-spread adoption in over 15 countries.

But the implications go further. As the algorithms became better known we were approached for permission to translate them into other languages (Java and Python) so that they could be

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incorporated into public access software libraries (ImageJ and SciPy). Their presence in these international libraries magnifies our impact. This is the subject of one of our impact case studies.

3. Managing Relationships.

An important element of our strategy is an active approach to partner relationships. Via the extra resources of ERDF funds, we have developed a sophisticated CRM system. We have records of all of our interactions with any company we have worked with; who spoke with them, names and job titles of individuals in the company, contact details, what actions were taken, references to correspondence, *de minimis* levels, etc. This has three wider benefits:

- It captures outputs and evidence of impact at the time that they happen.
- Anyone in GERI coming into contact with a company can see the history of our interaction with them. It impresses companies that we are able to “link-up” different parts of their organisation, instilling confidence in our track-record, efficiency and professionalism.
- It enables us to keep in-touch with existing and previous partners – keeping the contacts warm. Our CRM is a major factor in getting high levels of industrial attendance at events such as the “Lab Open Day” referred to above.

Placing Our PhD Graduates Inside Companies.

Our PhD graduates are actively sought by industry and we benefit from the resulting relationship. During this assessment period we have had PhD graduates employed by companies including; Sellafield, Cambridge Silicon Radio, Jaguar Land Rover and Cinetic-Landis. In addition, we have also had part-time, industrially based, PhD students from; GETRAG-Ford and Delphi Electronics in this period.

c. Strategy and plans

Generating impact is a mature activity within GERI and we see the future in an evolutionary form rather than involving radical change. Successful delivery of the current ERDF SME-engagement project remains our immediate priority, as this captures the ethos of our approach and is the mainstay of our short-term plans. We will also continue to promote our phase unwrapping work and maintain our multi-national industrial links.

In the medium term we will continue our multi-stranded strategy, whilst being flexible and responsive to opportunities as they present themselves.

A pro-active approach to impact must be well resourced, thus a strategic challenge is to ensure the continued availability of such resources. GERI’s long-term record in impact/commercialisation projects secures it the continuing support of the university in terms of investing matched income to underpin future ERDF bids; whilst our successful project delivery, alongside our close and supportive relationship with the LEP, puts us in a strong position to secure further funding from such bids. We are preparing a collaborative bid with other regional knowledge providers aimed at developing a large-scale, multi-themed “Advanced Manufacturing Centre”. There is a widely recognised need for such a resource in the region and accommodation for such a Centre is currently under consideration within the university. Such wider portals are one of the ways that GERI plans to continue resourcing and delivering its impact activities.

d. Relationship to case studies

Case Study 1: ‘Phase Unwrapping Software’, describes our experiences in innovative dissemination, showing how a series of papers, written to describe new approaches to an optical metrology problem, evolved into a suite of algorithms that have been widely adopted in a number of disparate fields. This is a good example of GERI being prepared to seize an opportunity and take up a flexible position in order to foster use of its research outputs by third parties.

Case Study 2: ‘Improving Fluid Delivery in Abrasive Machining’, describes an example of our work with multi-national manufacturing companies. This covers a body of work, the common theme of which was temperature control and cooling during abrasive machining. The work ranges from fundamental studies on heat generation during the process, to understanding the physics of fluid flow, in both delivery systems and the cutting zone itself. The theoretical work is underpinned by experiments undertaken under typical industrial conditions. This case study is a good example of the translation of very fundamental work into industrial practice and shows the value of having “hard data” with which to convince industrial colleagues to change age-long accepted practices.