Institution: University of Wales Trinity Saint David

Unit of Assessment: 15 (General Engineering)

a. Context. The strength of the Unit is in its combined approach to design and engineering which responds to a peculiarity of the Welsh manufacturing sector, which is characterised by the design-led requirements of OEMs (Original Equipment Manufacturers), who are often small to medium sized enterprises (SMEs). Typically, these companies are part of a larger supply chain, particularly in the automotive manufacturing sector, where some 20,000 employees in the South Wales corridor supply international OEMs such as Nissan, Ford, GM and Jaguar Land-Rover. The support given to these companies enables them to improve their product reliability, by for example, undertaking Non-Destructive Testing and manufacturing process improvement. The Unit also supports SMEs to develop their own expertise to develop new, innovative design solutions for problems that are often near-to-market. This is vital for the sector as it is dominated by companies with less than ten staff, where there is limited expertise and capacity to extend their product range. The support given to these companies is normally derived from the Unit's expertise in the Computational Modelling Group, Product Engineering & Design Group and the NDT Group. By combining innovative design solutions that consider end-user requirements as well as functionality, we provide solutions that bring a competitive edge to the local manufacturing supply chain. Our Knowledge Transfer activities reflect this problem-led applied research principle. Our succession of ERDF grants in the area of Composites and NDT reflect our focus on these areas in engineering and our vision is to continue to support the composites manufacturing sector in particular.

Non-destructive testing. The specialist NDT group can be traced back to the early 1990s, where industry-based PhD work in Magnetic Flux Leakage and Thermography was conducted. This was enhanced in 2005 by our partnership with TWI Ltd in the commissioning of the new NDT Validation Centre at Port Talbot, which saw the co-location of £0.75M of the Unit's NDT equipment. The Unit's Senior Research Fellow, Dr Peter Charlton, now works in close partnerships with TWI staff to provide NDT solutions for many of our ERDF sponsored projects, a knowledge transfer mechanism which is also extended by several TWI based PhD projects.

Computational modelling. The Computational Modelling Group undertakes two distinct types of collaborative work: **1)** Industrial standard multiphysics applications for stress and fatigue predictions. This approach is employed on windscreen damage research for Belron PLC, the world's largest vehicle glass repair and replacement company, as well as SME's in the OEM supply chain in order to improve their components. **2)** Collaborative work undertaken is based on the in-house developed modelling codes for simulating light-tissue interaction. The beneficiaries are locally based medical device companies that design, develop and manufacture light-based products for home use. See, for example, http://ipulse.co.uk/technology. This work has led to the Group's collaboration with Swansea University's Institute of Life Sciences.

Examples of our support for industry include:

- Oceaneering Ltd: Evaluation of electromagnetic acoustic transducer pipe corrosion inspection system: leading to £30k investment at company and one new NDT service launched.
- Silverwing Ltd: Finite Element investigation into new Magnetic Leakage Inspection tools: leading to 2 jobs created, 1 product launched.
- Knauf Insulation Ltd: Conveyer belt weld inspection method and evaluation: leading to £97k investment and 1 new process launched.
- TWI Ltd: Development of a real-time full matrix capture ultrasonic system. This project has implemented G.P.U. acceleration to produce a real-time data acquisition system for the 128-transducer probe used in the FMC system. In addition, novel algorithms, using a modified Kirchhoff migration method and the Synthetic Aperture Focussing Technique, have extend the applicability of the system to enable inspection of components with irregular boundaries. The benefit to TWI is the design and validation of a new marketable inspection system that has improved resolution and shortened inspection times compared to competitor products.

b. Approach to impact. Structural funds to support the Unit's impact strategy have come from two major projects: the Institute of Sustainable Design (ISD) (£4.7M) and the Unit's role in the Advanced Sustainable Manufacturing Technologies project (ASTUTE) (£27M). In addition, a

succession of EU / Welsh Government funded Academic Expertise For Business (A4B) projects have been undertaken to support our activities in NDT and Composites Manufacturing. Staff are supported in their knowledge transfer activities by secondment to these ERDF projects. Examples currently include Dr Ian Walsh, Prof Vanessa Cutler and C. Thomas, each fractionally seconded to the ISD project, Dr Owen Williams and R Thomas part seconded to A4B projects, and Prof Donne and Dr Al-Hussany part seconded to the ASTUTE project. The Unit organises public seminars to disseminate its research potential and to explore opportunities for industrial collaboration. The £4.7M Institute of Sustainable Design http://www.isdwales.com is the latest expression of the integrated approach to knowledge transfer to the manufacturing sector. Running from October 2011 through to June 2015 with funding from ERDF, our plan is to submit a successor project to continue the knowledge transfer support to industry through to 2020. Two examples of projects, partners and impacts include:

- **PROMOVE UK Ltd:** ISD were approached by Promove UK Ltd to provide support in developing an orthotic assistive device primarily for use by muscular dystrophy sufferers. After an initial scoping session with Promove UK, ISD outlined a collaborative R&D agreement which offered support to Promove in the form of collecting research data, concept development and CAD modelling, prototyping, FEA & physical testing and detailed design / design for manufacture. The project involves support over a 12-month timescale with contributions from the University and the client totalling £28,451 (to date). As a result of the R&D collaboration the University has ownership of the undeveloped designs and academic publishing rights. The client, Promove UK Ltd takes ownership of the Orthortic device with the view to manufacture.

- **SOLRAY Ltd:** Solray initially approached ISD through a Digital Design workshop. The company was interested in finding out more about the new technologies available and the potential for their business. As specialist suppliers of radiant heating panels, providing design, manufacture, supply and installation, Solray wanted to look at improving the design process for their products in order to offer clients a more comprehensive design and quoting service. They were in the initial stages of exploring the different 3D CAD systems available. Through a series of workshops and one-to-one sessions, ISD staff were able to offer expert advice and demonstrations on some of the different digital design and visualisation techniques available. By accessing the ISD Digital Design lab, Solray were able to view and try out a range of 3D CAD solutions before committing to a suitable system. Solray have now invested in new software and adopted new methods of visualising their product and integrating them into customer's premises. The implementation of this new digital visualisation process has allowed them to secure new work with a major supermarket chain.

Cerebra Innovation Centre. Another example of the Unit's combined design and engineering impact strategy is our seven-year collaboration with Cerebra, a national charity for brain-injured children. We have created a joint venture, the Cerebra Innovation Centre (CIC) that employs UWTSD and Cerebra full time staff on innovative solutions for life-style problems. Since its inception CIC has improved the lives of many children with neurological conditions. The unique strategic vision for CIC means that they are able to respond to individual requests for help and can make small numbers of bespoke products that focus heavily on individual requirements and inclusion into society. CIC responds directly to requests from parents thereby negating the complication and time constraints that arise when government bodies become involved. Some of the products in the portfolio are now being commercialised in partnership with third party manufacturers under licensing agreements. Since 2008 CIC have completed 592 member-requests for help and have produced 168 bespoke products including mobility and communication aids, products to enable IT access and sledges.

Medical Device Modelling. The computational work in light-tissue interaction commenced over twenty years ago and is driven by local medical device companies that design flash-lamp and laser products for markets with darker skin tones, where the therapeutic benefits of the intense light might be offset by increased absorption in the melanin-rich epidermis. Modelling of the anisotropic radiative transport with consequent photo-thermal and photo-chemical processes enables the device designers to select the optimum pulse characteristics for each skin tone. One

example of this collaborative research is a successful POWIS PhD project with Cyden Ltd, which was concerned with extending the existing light-based hair epilator device to overseas markets where there are darker skin tones. The modelling enabled the device designers to select optimal temporal pulse profiles that minimised damage to the skin epidermis whilst maximising damage to the sub-cutaneous hair follicle target.

Composites Manufacturing Support. A representative example of our composites manufacturing support is our EPSRC sponsored project with United Aerospace Ltd. This provided an in-depth study of cutting operations for composites, where the choice of cutting tools is critical in maintaining work-piece quality. This study has provided the company with new milling and drilling process information and tool selection criteria that will improve its competitiveness in the market. A second example is with TWI Ltd, where a POWIS project has considered the applicability of pulsed and lock-in thermography for the detection of defects in aerospace composites. This project utilised the expertise from the Unit's NDT and Manufacturing groups. The Unit's Collaborative Industrial Research Project (CIRP) is also supporting targeted SMEs in the launch of a composite off-road quad-cycle for people with disabilities. This project is run in collaboration with Gower F.E. College and the private sector. The purpose is to design, develop and manufacture a prototype four wheeled mountain bike predominantly for use by disabled people by addressing a number key of engineering design issues. These include: design for economic manufacture in order to give a more affordable selling price, address suspension and performance issues, utilise high strength lightweight modern materials and improve overall robustness and durability. This £540k project, of which UWTSD receives £122k, also addresses a number of wider themes including healthy living, environmental sustainability, tourism and inclusive disability sport. Research to date, from an ERDF funded feasibility study, indicates a domestic and international market need for such a product and many UK and European downhill trails are suitable for a four wheeled bike. The target market includes commercial customers such as Disability User Groups, Charities, Bike Hire Centres and individuals.

c. Strategy and plans. The Unit is committed to developing new knowledge transfer projects with local industry and has corresponding targets set by the University's research strategy. The strategy will remain focussed on the Welsh manufacturing sector and will embrace innovative design, lean manufacturing and NDT. We plan to express this integrated, cross-disciplinary approach in how we support the automotive manufacturing sector, particularly in the increasing use of light-weight composite components, often seen as metal/composite hybrid parts. The current collaboration with the pan-Wales ASTUTE project, and the £4.7M Institute of Sustainable Design and their successors for the period 2014-2020 will form the main pillar of our cross-disciplinary approach. The underpinning research themes will be i) Non Destructive Testing and its application to both metal and composite materials, ii) computational modelling of radiation and thermal transports, and iii) design innovation and its integration with the manufacturing sector. Our strategy will also take cognisance of forthcoming Horizon 2020 calls, so that our knowledge transfer activity under structural funding will link closely with our applied research activity under H2020.

d. Relationship to case studies. The Unit's research strategy is driven by its engagement with industry, particularly near-to-market knowledge transfer activities. The two impact case studies build on the research outputs evidenced in RAE2008 and illustrate the Unit's approach to problem-led, applied research in partnership with the private sector. Our work for Belron has developed for over twenty years by providing objective scientific understanding of windscreen damage keeps Belron at a competitive advantage. This approach is common to the majority of all our research, in that project work has an industrial focus. The KTC Case Study likewise illustrates the distinctive approach that this Unit takes, in that it specifically addresses near-to-market problems often experienced by the Welsh manufacturing sector, which is dominated by companies with typically less than ten staff. This more applied research approach reflects the key strength of the Unit, which is its willingness to improve the competitiveness of small companies that are in the second and third tier of the manufacturing supply chain.