RCNDE
UK Research Centre in NDE

Research & Exploitation Newsletter

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RCNDE Core research programme for 2018-2020

The current six-year phase of RCNDE runs from 2014 to 2020 and includes, among other activities, an initial four-year core research programme covering period from 2014 until 2018.

This core programme is divided into four themes – Enhanced Imaging, Accurate Characterisation, New Technologies and Permanent Monitoring – and comprises eleven separate research projects spanning the six universities in the RCNDE consortium. These projects are mainly being funded by a grant awarded by the Engineering & Physical Science Research Council (EPSRC), although they are also partly funded by the industrial and university members of RCNDE too.

The final two years of the current phase of RCNDE, and starting in April 2018, marked the start of a new tranche of core research projects. There are seven new projects again covering the same four principal themes and undertaken by the university consortium. The topics are:

- Coping with complexity: integration of simulation tools for inspection of complex components (Imperial)
- Modelling normal and abnormal appearance for automated analysis of NDE images (Manchester)
- Acoustic-based characterisation of arc fusion process and the effect on long-term defect initiation (Strathclyde)

Automated Defect-Free Fusion Welding (ADFFW) cell at the University of Strathclyde

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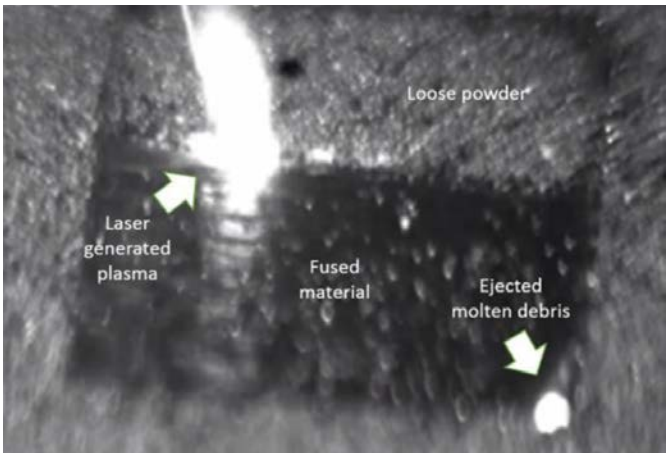


Laser-powder interaction phenomena during additive manufacturing process (Selective Laser Melting), whereby unstable and stochastic process dynamics can potentially result in poor fusion characteristics. An inspection methodology is clearly necessary to assure part integrity.

- Feature-specific imaging (Bristol)
- Driving additive manufacturing through NDE (Nottingham)
- Remote and automated delivery of non-contact NDE sensors (Warwick/Strathclyde)
- Improved coverage and sensitivity in permanently installed monitoring (Imperial)

These projects were selected by the industrial members, based on their companies' interests and the strategic importance, from a longer list of fifteen proposals. They will be entirely funded by the academic and industrial members of RCNDE, although mostly using funds collected from industrial membership funds during the current phase of RCNDE.

Linking NDE & Structural integrity

RCNDE members have previously identified that linking NDE and Structural Integrity (SI) better could help steer the application and future research in both areas, and identify how NDE developments can help to provide improvements to overall integrity management. For example, what extra NDE information would be of most use to the SI community, and what would the SI community like to know more about materials and defects that could enhance and enable novel approaches to SI?

The UK Forum for Engineering Structural Integrity (FESI), is a membership-based organisation set up to disseminate latest advances in SI, to promote the exchange of technologies and knowledge between industrial, regulatory, academic and professional organisations, to encourage best practice, and to provide a practical resource for anyone working in SI. FESI aims to help improve the safe performance of, and realise the economic potential inherent in, the UK's engineering assets.

There are clear linkages between the NDE and SI communities and several organisations are members of both RCNDE and FESI. Last November, RCNDE collaborated with FESI to hold an event to explore the opportunities in this interface between related disciplines. The objective was to identify:

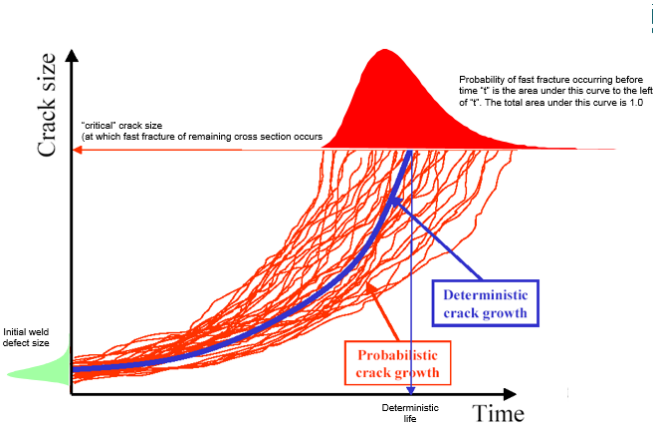
- Opportunities for advances in NDE technologies and capabilities to support improved abilities for making better engineering integrity judgements and decisions;
- The potential for new or improved approaches to SI if advances in NDE capability were to become available; and,
- The priorities for future research to address the opportunities arising.

Presentations were given by representatives from Wood, University of Bristol and Atkins, University of Bristol and TWI, Office for Nuclear Regulation, EDF Energy, Uniper, and Frazer-Nash Consultancy.

During a structured workshop session, the participants considered whether there were opportunities to improve SI assessment throughout the asset life cycle (design and qualification, manufacture, in-service, life extension) by considering: (a) improved ways to use existing NDE capabilities, (b) the need for new NDE capabilities, and (c) changes to SI approaches to maximise use of NDE capabilities. A range of ideas were captured which will be used by the respective communities to develop research proposals.

Examples of opportunities identified were:

- Find smaller/better characterised defects to run plant longer & harder
- Opportunity for more probabilistic approaches
- 'Design for inspection' – although happening in some critical cases, there is scope for better engagement with manufacturers for broader use
- Scope for better planning for life extension at design stage
- Accurate defect growth rate measurements from monitoring could provide useful feedback to predictions where models uncertain.



Probabilistic life prediction – guidance in BS 7910 (Image from presentation by Prof. D Knowles, University of Bristol/Atkins

Following the workshop session, several priorities for advancing this area included obtaining more information for sectors not covered in detail during workshop such as oil & gas and manufacturing. Also, industry needs to look at ways to improve the present 'disconnect' between manufacturers and operators regarding 'design for inspection' and lifetime optimisation. Finally, although this workshop focused on SI/NDE links, there are opportunities for broader linkages with other disciplines and fields, such as stress, materials, etc.

Robotics for vessel inspection

Non-intrusive inspection for pressure vessels and offshore assets has been a key priority for the Aberdeen-based Oil & Gas Technology Centre (OGTC), and it estimates the use of robotics to inspect pressure vessels could save the energy industry more than £240 million per year. The OGTC has recently announced investment in new projects aimed at improving the safety of vessel inspections offshore, including two involving the robotics technologies developed partly from past phases of RCNDE research at the University of Strathclyde.

The first is working to develop a new robot crawler, equipped with a combination of wide field-of-view cameras and 3D laser scanning and testing technologies. Existing crawlers can only be used when there is a clear line-of-sight for the operator. The new robot's scanning capabilities will create a 3D representation of the inspection site, meaning it can be operated remotely.

The other project is to develop technology involving swarms of small, unmanned aerial vehicles (UAVs) for sophisticated inspection of offshore platforms. Drone swarms are already being adopted by the military for logistics operations, and adoption for vessel inspection could provide a safe and cost-effective alternative to human inspection.

Public engagement: Royal Society Summer Science Exhibition

The RCNDE members, both academic and industrial, are keen advocates for engineering and the physical sciences and they collectively made a commitment in the current RCNDE programme to extend these activities. This includes a range of activities to promote the value of NDE to government, policy makers, UK industry and the public. As part of this public engagement, RCNDE successfully applied for an exhibition stand at the recent Royal Society Summer Science Exhibition last July.

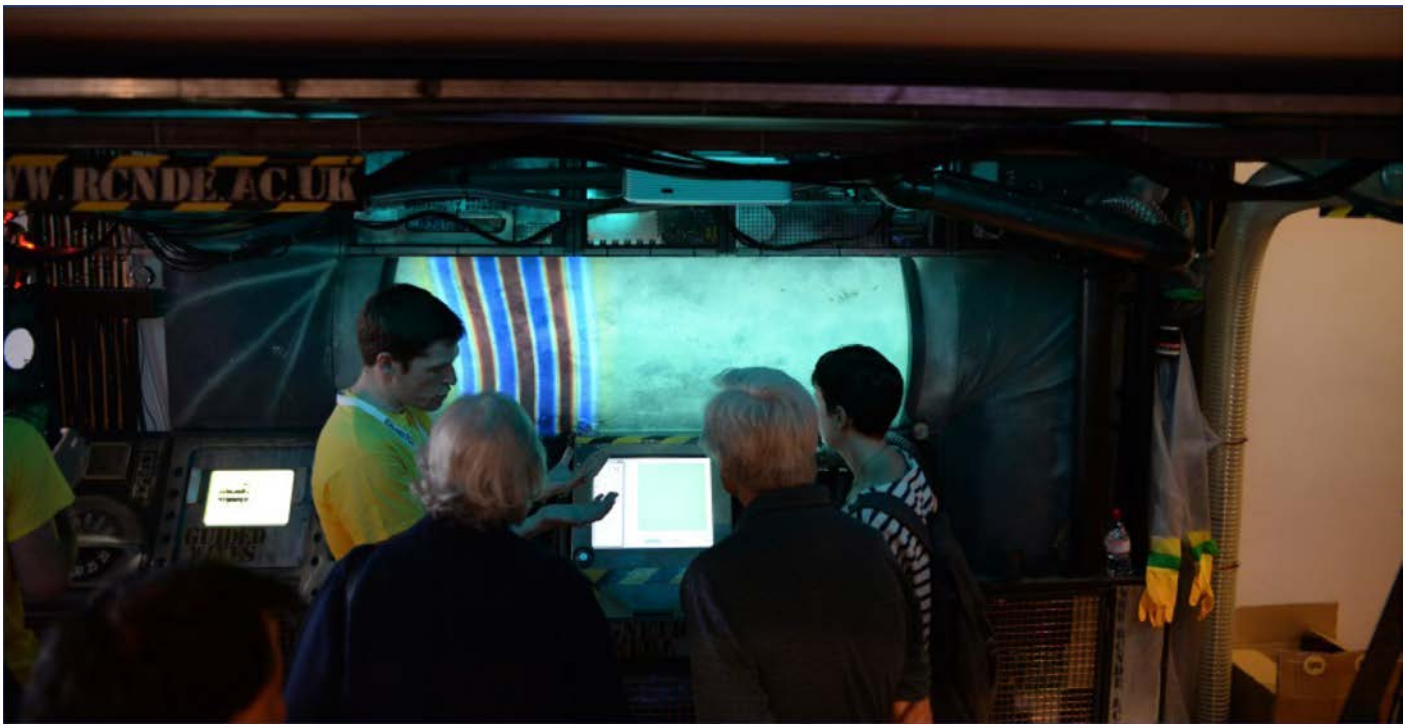
The RCNDE 'Safe and Sound' stand was one of 22 exhibits, selected in a highly competitive process, featuring cutting-edge science and research from across the UK. The exhibition is considered to be one of the leading UK science exhibitions. The RCNDE stand was designed to reflect the difficult conditions in which it is often necessary to perform NDT measurements: confined and cluttered spaces, dark, hot, and potentially radioactive environments. Hands-on demonstrations included guided ultrasonic waves for pipe inspection, embedded wireless inductively coupled ultrasonic sensors, magnetic camera and wheel-tap test. The stand was manned by RCNDE doctoral students, researchers, academic and industrial members. Feedback from the public was very encouraging and the RCNDE stand and exhibit really helped to get the message across that engineers and scientists play a vital role by testing engineering structures to ensure they are safe whether it is to keep planes flying, trains running or power stations operating.

Royal Commission of 1851 success for doctoral centre students

The Royal Commission for the Exhibition of 1851 was established in 1850 to organise the first world trade fair. The Great Exhibition opened on 1 May 1851 at the iconic Crystal Palace with 100,000 exhibits and was a big success including making a substantial profit. When the Exhibition closed later that year, the Royal Commission was then established as a permanent body to spend the profits to realise its goal to "increase the means of industrial education and extend the influence of science and art upon productive industry". Following the Commission aiding the establishment of the Science and Natural History Museums, and Imperial College among other institutions in South Kensington, sufficient funds remained for the Commission to set up an educational trust to perpetuate its aims.

Today, the Commission awards a range of fellowships supporting researchers and students at the early stages of their career. The Industrial Fellowships scheme is of particular relevance to doctoral students. The aim of the scheme is to encourage profitable innovation and creativity in industry – to the mutual benefit of the Fellow and his or her sponsoring company. Projects can be in any science or engineering discipline. These prestigious Fellowships are awarded to exceptional graduates with the potential to make an outstanding contribution to industry through a programme of doctoral-level research, and are open to company-employed candidates or Doctoral Centre/ Industrial CASE candidates.

RCNDE RSSSE stand showing a visual simulation of guided ultrasonic waves travelling along a pipe.



Royal Commission of 1851 success for doctoral centre students (cont.)

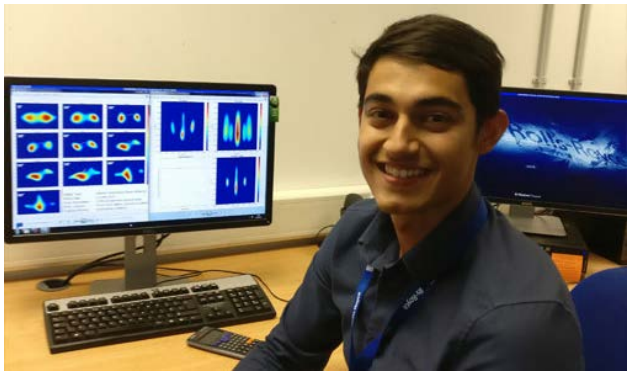
The Engineering Doctoral Centre in NDE has had nine fellows over the 12 years since the first doctoral centre cohort in October 2005, which is a remarkable achievement and a testament to the quality of the doctoral centre students. Fellows include:

Misty Haith (BP Exploration and Imperial College London) aimed to improve the quality and reliability of the inspection of sub-sea pipelines. Advances in digital radiography techniques have made this a feasible method of sub-sea inspection, however it is an extremely time consuming and expensive process. By `stitching' multiple radiographs into a single image via new calibration software, the project sought to improve both the reliability and area coverage of inspections while simultaneously reducing their cost.

Misty Haith (above, upper) and Tom Barber (above, lower) receiving their Industrial Fellowships from Rt Hon Greg Clark MP Minister for Universities, Science and Cities

Thomas Barber (BAE Systems and the University of Bristol) developed an automated system able to inspect the quality of welds in small-bore pipework used on board submarines. The new technique involves replacing radiography with advanced ultrasonic imaging techniques, improving inspection capability while decreasing manufacturing costs and making the workplace safer.

Joshua Elliott (Rolls-Royce and Imperial College London) is researching the capabilities of Super Resolution ultrasonic imaging algorithms for use in NDE inspections of defects within safety-critical submarine nuclear plant components. Through doing this, he aims to optimise the algorithms for several industrial applications. Current conventional

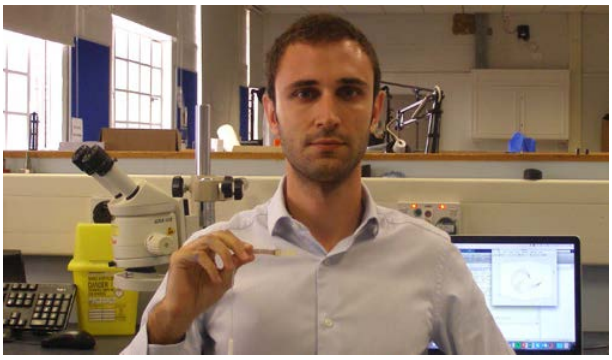


Joshua Elliott

ultrasonic NDE methods are often conservative in their approach, inevitably leading to unnecessary expenditure following routine component inspections.

Arnau Garriga Casanovas (Rolls-Royce and Imperial College London) is developing a snake-robot capable of deploying probes inside aircraft engines to inspect them for potential cracks using ultrasonic sensors. Currently typical crack inspections often require the complete dismantling of the engine, which involves significant cost and disruption to fleet operators. The use of snake-robot technology is expected to enable the inspections to be carried out on-wing, without the need for disassembly, providing substantial cost savings while ensuring safety.

Other fellows from the NDE doctoral centre include Christopher Lane, Maria Felice, Alexander Ballisat, Jethro Coulson and Nicolas Brierley.



Arnau Garriga Casanovas

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