ENGINEERING INTEGRITY SOCIETY

WORTH 6 HOURS OF CPD

SEMINAR: Uncertainty of Measurement

17 November 2022, AMRC, Sheffield

Certainty is completely different to accuracy, errors, linearity and other measurements associated with good data. It is perfectly possible to have amazingly good and accurate data, and still be uncertain of the result you have.

This seminar will cover some practical situations in measurement, data collection and analysis where even with very accurate measurements, good transducers, accurate analysis models, it is still possible to make the wrong conclusions, or not be able to prove a result is correct. The usual reason is not understanding the actual problem, assumptions or not considering other factors. In other words, “the scientific method”. In fact, the goal is to do as few tests or analyses as possible and get one answer, to provide a faster result. It is too easy to assume that the expensive, accurate, and complex transducers we fit must produce the right answer. The seminar will look at some concrete examples of accurate and repeatable measurements where the certainty of a good result could be very suspect.

Provisional Presentations

Gaining Traction - Engineering in the face of uncertainty - Lessons from the World Rally Car - Damian Harty, REE
In contrast to circuit racing, rallying is broadly impossible to predict exactly. Despite enormous advances in computational budget, there will always be a bigger rock to overcome. The process of gaining traction - both literally and metaphorically - is not intuitive and yet is possible to approach in a structured way. This paper lays out a philosophical stance and illustrates it with practical examples and real world data.

Uncertainties within a calibration laboratory - Miles Dadson, Proctor and Chester Measurements Ltd
This presentation introduces the concept of uncertainty of measurement as used within a load cell calibration laboratory, differences and limitations between types of calibration machinery with their associated uncertainties. Drawing upon recognised standards and industry best practice to establish contributors and their effects, with examples showing the influences on results reported in calibration certificates.

Uncertainty Collection – a materials testing case study on variability outside the specimen - Peter Bailey, Instron
This presentation will discuss the way in which different aspects of equipment, operation and analysis can affect data collected and the results generated. Considerations range from transducer calibration and drift, noise and control stability, physical preparation of test pieces, through to data recording and handling. In each case we will briefly consider why it happens and how the size of its impact might be estimated.

Considering Uncertainty, "Are you sure you have the correct answer?" – David Ensor, EIS
When performing analyses on collected data or test results a persistent follow-up question is "how certain are we in the result?". Well, this is a complex issue and it is time to go through some of the methods used to know how certain we are. There are many aspects to consider. Such as how certain you are that the transducers measure what you actually want, the data collection process is repeatable, the test itself is realistic, and even what or why you are testing anyway. Essentially we need to review 'the scientific method'. Getting this wrong can mean that you think you have THE answer, when in fact you have missed the actual problem and you may just have AN answer. The lecture will describe examples where some quite exhaustive data collection and subsequent analyses have provided very good data, but little if any certainty in the solutions produced. A light-hearted example exercise will be conducted to help set the scene. We will consider the reasoning behind how many items to test, how many tests to repeat, have we covered all the variables, are we testing realistically, did the measurement measure what we though it should, and many others.

Quantifying the Effects of Uncertainty in Correlating Fatigue Life Simulation with Physical Tests - Andrew Halfpenny, HBK
Fatigue is defined as: "the progressive weakening of a material caused by cyclic or otherwise varying loads, even though the resulting stresses are well within the static strength limits." Fatigue failures often initiate at a microscopic level and no two components are identical at this scale. Materials are inherently variable, and for most engineering purposes they are modelled empirically to account for these inconsistencies. Furthermore, uncertainties in loading, residual stresses, and other effects, compound to have a significant influence on the overall uncertainty of fatigue life.
This presentation demonstrates how fatigue life simulations may be correlated with physical reliability tests whilst accounting for the wide-ranging uncertainty in life measurements. A case study demonstrates how the methods are applied to an air-cooled intercooler. A comparison is made between fatigue simulation and physical reliability test results. The simulation is shown to offer excellent correlation with the experimental measurements. No further improvements in the model were deemed necessary and the model is considered a suitable platform for performing design simulations and for extrapolating the reliability statistics.

Can you control all your test variables? We don't! - Connor Bligh, JCB
If you've ever collected real life data then you know that field testing can be difficult even on the good days. Managing the machine, operator, weather, track, data loggers, analysis, etc. all variables with the potential to affect the data. With a large product range of complex machines, a global market and thousands of users in thousands of conditions, can you ever control all the required testing variables? More importantly, does it even matter? Connor will discuss some of the ways we manage our variables and which variables we cannot currently control.

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The annual subscription rates are £25+VAT for UK residents and £30+VAT for non-UK residents. Upon joining the Society you will also have the additional advantages of preferential attendance rates at EIS events, together with selected events held by some of the associated organisations. In addition you will have access to archived copies of EIS presentations.

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