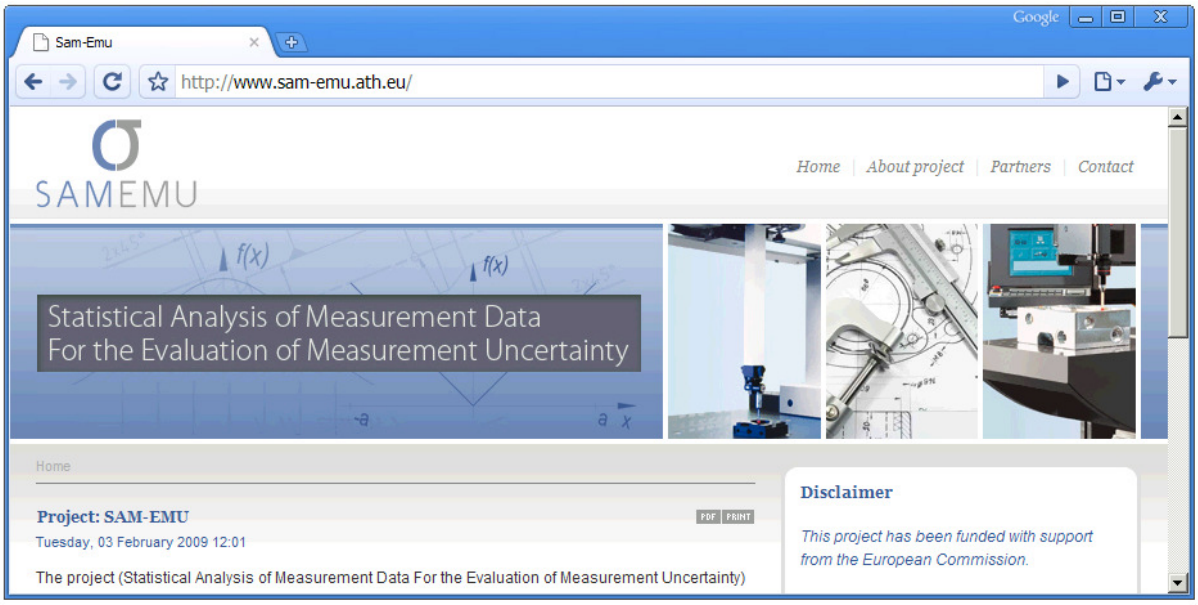

Evaluation of Measurement Uncertainty

Statistical Analysis of Measurement Data for the Evaluation of Measurement Uncertainty (SAM-EMU) - An essential online course to empower product engineers. By Professor Liam Blunt and Mr Tukun Li, University of Huddersfield.

In the era of global marketing and outsourcing, a knowledge of measurement uncertainty is essential for a modern engineer. The mere mention of assigning uncertainty budgets sends cold shivers down many an engineer's spine. However designers need to understand uncertainty to more precisely predict the future performance of a component and ambiguously express his/her functional intent.

A production engineer requires a knowledge uncertainty to be able to evaluate the measurement uncertainty in any meaningful measurement. Clearly then, it is vital that those engineers use a standard method for evaluating and expressing uncertainty to facilitate global manufacturing capability.

The problem is that the knowledge of uncertainty itself has many uncertainties. This is due in the main to the fact that the philosophy of uncertainty has evolved as the results of the emerging methods and tools. Traditionally, the measurement uncertainty is solved solely by the probability method, and guidance is provided in the case of a single reading of a calibrated instrument. However, it is unable to deliver a sound solution to meet the requirements of modern manufacturing which are more reliant on computer science and information technology.

Thus, the definition of measurement uncertainty has been redefined and contains a new component called definitional uncertainty. A computer simulation method is introduced to ISO standards to estimate uncertainty in many so called "non-conventional" measuring methods (e.g. CMM). The concepts of specification uncertainty, correlation uncertainty etc. are introduced into the GPS languages to balance the information between designer, product engineer and metrologists. Therefore, it is important for engineers to appreciate the latest concepts of uncertainty in order to

adhere to the GPS movement.

Thus, for a practicing engineers, a reliable estimation of uncertainty is not an easy thing to achieve. He or she requires an interdisciplinary knowledge: covering a good knowledge of basic statistics, quality and metrology and most critically, good training in uncertainty. This is all before delving into the realms of assigning uncertainty budgets to given measurements

To empower European engineers, an e-learning system have been recently developed to help them to understand and evaluate of uncertainty in manufacturing metrology. It integrates contributions from different disciplines into a user-centred approach that strictly respects the necessary scientific precision and problem-solving approach of the field of engineering studies.

The content is based on a user needs survey carried out in academia and industry. This course is delivered by means of basic and specialised continuing e-training systems offering on-demand e-learning modules, as well as assistance systems that incorporate permanent participation in a ubiquitous e-learning community of experts. It consists of 30 hours learning material which covers up-to-date knowledge on the topic of uncertainty. It includes six modules:

1. Basic statistics
2. General methodology of uncertainty evaluation
3. Uncertainty of conventional measurements
4. Uncertainty of coordinate measurements
5. Uncertainty in surface roughness measurement
6. Uncertainty in case of multivariate measurands

The didactic materials provide a possibility to gain/refresh the necessary knowledge from probability and statistics, measuring equipment and measurement errors. The contents enable self-learning at a high level in the area of uncertainty. Many real-life examples explaining the methodology of evaluation of the uncertainty are included. The sources of necessary data for uncertainty evaluation are highlighted. The requisite experiments for calculation of the uncertainty are described.

The simulators enabling training and verification of knowledge gained are developed. Much attention is paid to the uncertainty of coordinate measurements which are the key-technique in mechanical manufacturing industry. Additionally simulation software has been developed to explain the source and mechanism of propagation of errors. It is predicted that the developed learning system will significantly ease the mastering of the philosophy and significance of the uncertainty problem.

Significant numbers of examples are integrated in the system to make users of the system aware that particular measuring situations are unique.

The learning resources of the course are accessible at the workplace. These include attractive links, small training tasks and self-assessment questions that should encourage users to broaden their learning, to go into greater depth and to take a more systematic learning path.

As those e-learning resources are constantly available, and as users are always able and encouraged to customise the direction and profoundness of their competence learners can work at their own pace or in their own time.

A recent pilot implementation, involved 50 participants from more than 10 different countries, has been highly complimentary of the course its structure and contents.

e-mail: l.a.blunt@hud.ac.uk

The course is available at www.sam-emu.ath.eu