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Li, T., Blunt, Liam and Jiang, Xiang

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# Uncertainty in Surface Roughness Measurement

T. Li, L. Blunt and X. Jiang

Centre for Precision Technologies,  
School of Computing and Engineering, University of Huddersfield,  
Huddersfield HD1 3DH, UK



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## Problem:

For a measurement to be meaningful, a statement of uncertainty must accompany the result. However, surface roughness measurement is relatively immature in terms of the provision of statements of uncertainty and it is usually the case that no statement is provided at all!

## Aim:

The aim of this project is to develop and implement a coherent learning system which can be a supplement for existing curricula of engineering studies and higher-level vocational training concerning the uncertainty of surface roughness measurement.

## Source of Uncertainty (Stylus Instrument):

- X-Axis
- Z-Axis
- Lc filtering
- Ls filtering
- Stylus tip
- Measuring force
- Sampling interval
- Software
- Inhomogeneity of surface
- ....

## Estimate of Uncertainty:

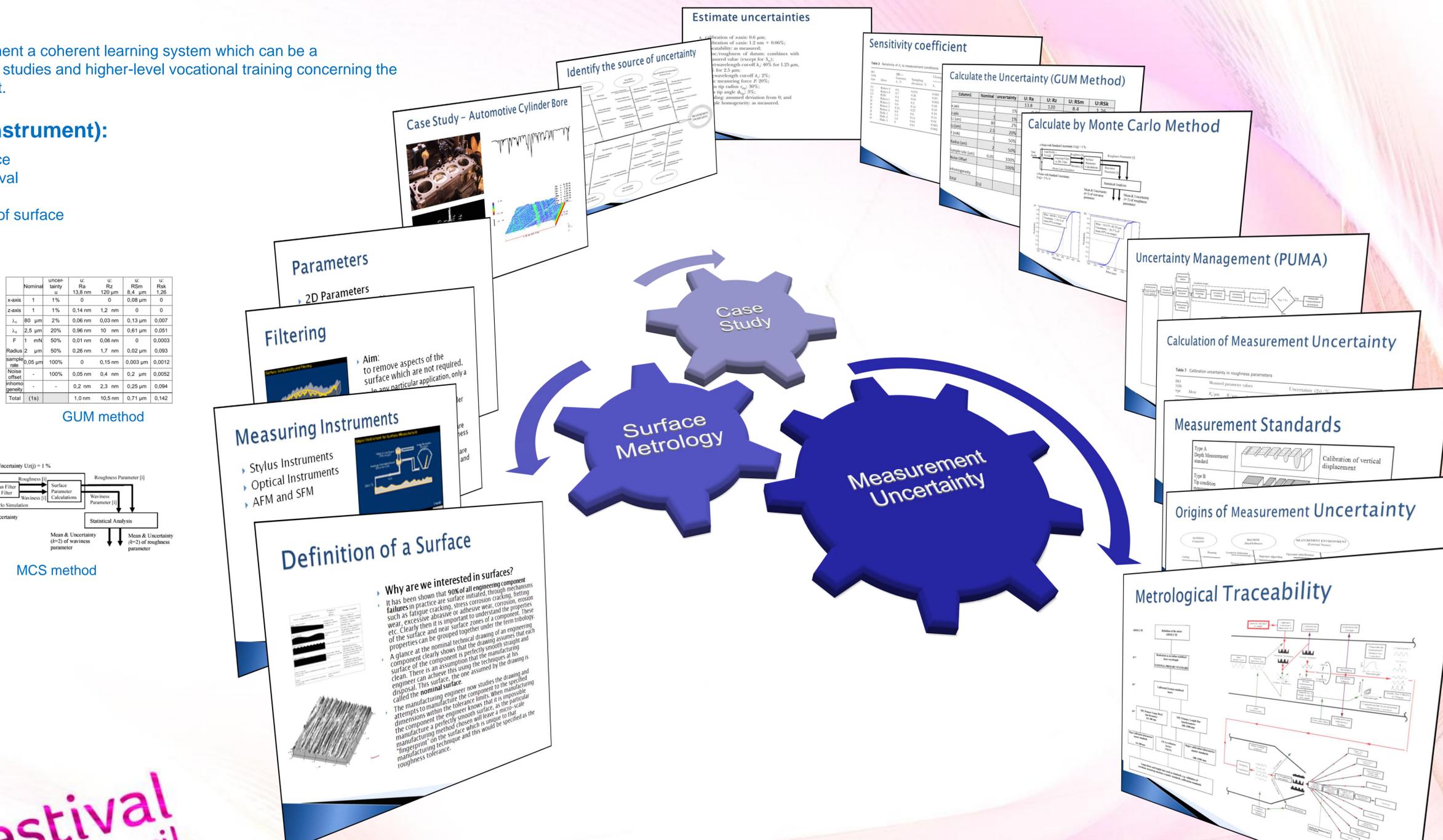
There are various approaches to obtaining an estimate for the value of a measure together with its associated standard uncertainty. The ISO Guide to the Expression of Uncertainty in Measurement (GUM) is widely used and accepted as an approach to uncertainty evaluation.

In recent times, more general approaches to uncertainty evaluation have gained recognition, including the use of Monte Carlo simulation (MCS). MCS is a computationally intensive approach to uncertainty evaluation, but removes many of the approximations that are part of an approach based on the GUM.

**Delivery:**  
This course will be available at:  
[www.sam-emu.ath.eu](http://www.sam-emu.ath.eu)

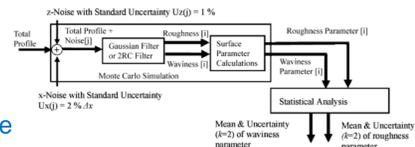


**Research Festival**  
23 March ~ 2 April  
**09**



	Nominal	uncertainty	u	u	u	u	u	u	u
x-axis	1	1%	0	0	0,08 μm	0	0	0	0
z-axis	1	1%	0,14 nm	1,2 nm	0	0	0	0	0
λ <sub>c</sub>	80 μm	2%	0,06 nm	0,03 nm	0,13 μm	0,007	0	0	0
λ <sub>s</sub>	2,5 μm	20%	0,96 nm	10 nm	0,61 μm	0,051	0	0	0
F	1 mN	50%	0,01 nm	0,06 nm	0	0,0003	0	0	0
Radius	2 μm	50%	0,26 nm	1,7 nm	0,02 μm	0,093	0	0	0
Sampling rate	0,05 μm	100%	0	0,15 nm	0,003 μm	0,0012	0	0	0
Noise offset	-	100%	0,05 nm	0,4 nm	0,2 μm	0,0052	0	0	0
Inhomogeneity	-	-	0,2 nm	2,3 nm	0,25 μm	0,094	0	0	0
Total (1σ)	-	-	1,0 nm	10,5 nm	0,71 μm	0,142	0	0	0

GUM method



MCS method

### Definition of a Surface

Why are we interested in surfaces?

- It has been shown that 90% of all engineering component failures in practice are surface initiated, through mechanisms such as fatigue cracking, stress corrosion cracking, erosion wear, excessive abrasive or adhesive wear, corrosion, erosion etc. Clearly then it is important to understand the properties of the surface and near surface zones of a component. These properties can be grouped together under the terminology of surface metrology.
- A glance at the nominal technical drawing of an engineering component clearly shows that the manufacturing surface of the component is perfectly smooth straight and clean. There is an assumption that the manufacturing engineer can achieve this using the techniques at his disposal. This surface, the one assumed by the drawing is called the **nominal surface**.
- The manufacturing engineer now studies the component and attempts to manufacture the component to the specified dimensions within the tolerance limits. When manufacturing the component the engineer knows that it is impossible to manufacture a perfectly smooth surface, as the particular manufacturing method chosen will leave a micro-scale "fingerprint" on the surface which is unique to that manufacturing technique and this would be specified as the roughness tolerance.



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[www.hud.ac.uk/researchfestival](http://www.hud.ac.uk/researchfestival)

