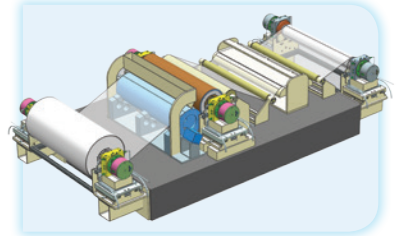
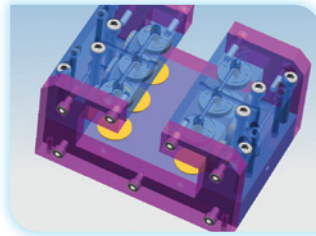
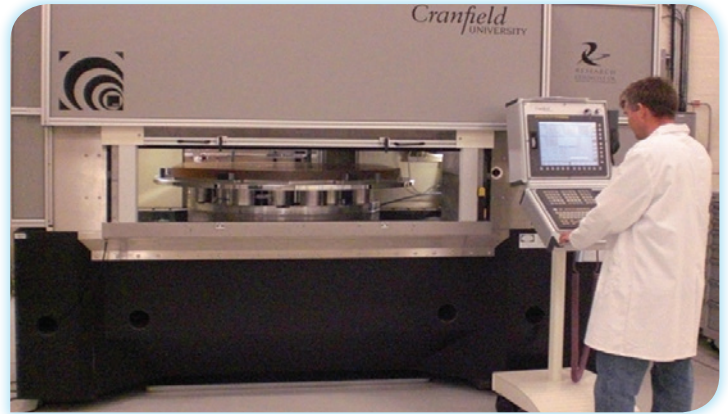
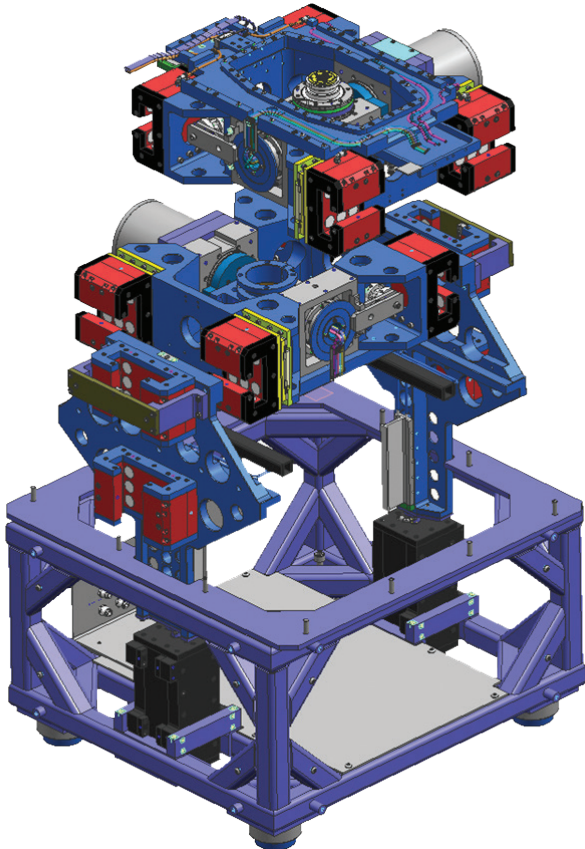




EPSRC Centre for innovative  
manufacturing in ultra precision

*Cranfield*  
UNIVERSITY



# Precision Engineering Industrial Short Course

## Venue

Cranfield University, Cranfield,  
Bedfordshire, MK43 0AL, UK.

## Date

21-25 September 2015

A highly practical, results orientated five day intensive short course covering the basic principles and state-of-the-art concepts to increase the precision, accuracy and reliability of machine tools and products.

## Course overview

### **Gain knowledge to increase the precision, accuracy and reliability of your machines and products**

This results orientated course focuses on how you can increase the precision and accuracy of machines, products and processes. Substantial benefits can be gained in a wide variety of applications ranging from ultra precision to traditional mass production. In design and manufacturing, increasing precision and accuracy can multiply opportunities and capabilities and lead to breakthroughs.

In automotive, optics, machine tools, general manufacturing, micro-electronics, instrumentation and other industries, increasing the precision and accuracy can result in products and processes with greater capabilities, better reliability, and higher quality. This in turn can produce higher productivity, better sales potential, higher profits and improved competitive position.

### **Gain awareness to help you increase the precision and profitability of manufacturing facilities you develop and purchase**

This course will give you the basic precision engineering principles and state-of-the-art concepts for designing higher precision and accuracy into your machines, products and processes, whether they are ultra precision or otherwise.

As an engineer you will find the basic principles to be simple yet powerful tools for improving machine performance; the latest concepts will put you at the forefront of precision engineering technology. The course will emphasise practical information that you will be able to apply immediately and profitably to your design and manufacturing efforts.

### **Who should attend?**

Engineers working in the machine tool, automotive, aerospace, optics and semiconductor industries. It is highly appropriate to individuals involved in purchasing high value precision engineering facilities where accuracy capability is critical to profitability and success.

### **Gain a valuable reference manual from the extensive course documentation**

You will receive an extensive course manual that includes all the course content and a broad selection of pertinent papers from a variety of sources. The manual will complement the lectures and provide an invaluable reference tool in your workplace.

### **Find solutions to your 'real' design and manufacturing problems from this interactive learning opportunity**

Throughout the course the speakers will encourage your questions, comments and participation. You are invited to come prepared with questions, issues and problems for discussion in relation to your specific design and manufacturing operations. Break times, lunches and evenings provide the opportunity for ongoing discussions with the instructors and also fellow participants. In addition, the final day of the course includes scheduled time for discussion and debate.

### **Opportunities for discussion with respected, and internationally recognised, precision engineering experts**

This course is based on the highly successful short course series developed by Professors Pat McKeown, John Corbett and Paul Shore at Cranfield University. It has previously been provided in Europe, the USA and numerous Asian countries during the last 20 years. With constant updating of content and with newly engaged internationally renowned instructors this course offers a unique blend of the most current technical knowledge.

# Course speakers

## Paul Shore

Paul Shore is Professor of Ultra Precision Technologies at Cranfield where he has developed the Cranfield University Precision Engineering activity to be world leading with unrivalled precision engineering research facilities and laboratories. Paul is a Fellow of the Royal Academy of Engineering and Immediate Past President of the European Society for Precision Engineering and Nanotechnology ([euspen](#)).

## Paul Morantz

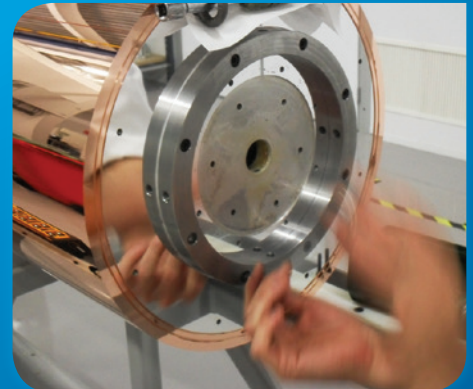
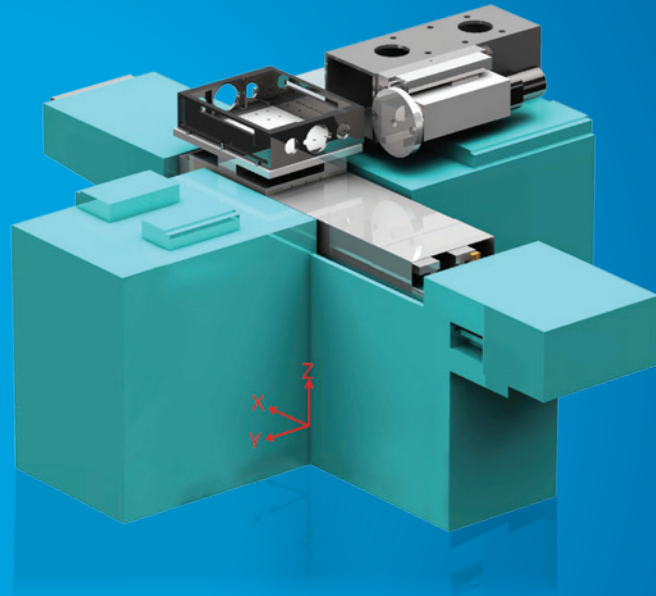
Paul Morantz is an internationally respected precision engineer and established project manager with an exceptional record in the fields of precision motion control, precision metrology and machine tool development. Having experience in the development and delivery of major precision engineering research and development programmes, he has additional experience in specialist software development and technology management.

## Richard May-Miller

Richard May-Miller is a Project Engineer at Cranfield Precision with particular experience in control software and metrology for high precision machines.

# International speakers

A selection of International speakers from academia and industry will be lecturing on this course, eminent in their relevant field of expertise.



# Timetable

## Day 1

**09.00 Welcome and introduction**

**09.30 Keynote: setting the scene**

- Precision engineering and nanotechnology
- The state-of-the-art and a world overview

**10.30 Break**

**11.00 The deterministic performance of machines**

- Fundamental importance of repeatability
- Non-repeatability sources and their reduction and control
- The 'deterministic' position

**12.15 Design of high-precision machines: Analysis, principles and techniques**

- The designer's guide to high precision, covering:
  - stability and optimum support of structures
  - the Abbe principle
  - error compensation techniques
  - drives/carriages

**13.15 Lunch**

**14.00 Mechatronics**

- The role and interaction of the different elements in a mechatronic system, including motion control, electronics, dynamics, actuation, optics and metrology
- Zero stiffness actuation with high stiffness control
- Classical PID control or modern optimised controllers, what's the future?

**15.30 Break**

**16.00 Mechatronics**

- Modal analysis of dynamics related to controlled motion and feedback stability
- Examples from IC Lithography and optical recording

## Day 2

**09.00 Kinematic constraints and structures**

**10.30 Break**

**11.00 Kinematic constraints and structures**

**13.00 Lunch**

**14.00 Precision motions actuation and sensing**

- Review of precision machine motion actuation and sensing technologies
- Selection guide for appropriate technology choice and deployment
- Design case studies

**16.00 Break**

**16.30 Control strategies for higher precision**

- Advanced control system concepts and features
- Optimising accuracy for static, dynamic and co-ordinated motions

**17.45 Visit to ultra precision laboratory**



## Day 3

### 09.00 Spindle designs for high precision

- Spindle system designs
- Comparison of bearing types
- Axes of rotation
- Examples in precision machine design
- Aids to design

### 10.30 Break

### 11.00 Slideway designs for high precision

- Guideway system designs
- Bearing types
- Motional accuracy
- Examples in precision machine design

### 12.30 Lunch

### 13.30 Thermal effects

- Gradient and cyclic variation-thermal drift
- 'Energy as an enemy'

### 15.00 Break

### 15.30 Thermal effects

- Air shower, liquid shower, and numerical compensation solutions
- Thermal environment for acceptance testing

## Day 4

### 09.00 Machine metrology and calibration

- Machine calibration: Parametric, artefact and global techniques
- Metrology frame techniques
- Other design issues

### 11.00 Break

### 11.30 Error budgeting: geometric and thermal

- Build up of an error budget (concepts)
- Statistical treatment of individual error estimates
- The importance of error budget at all stages of design

### 12.30 Lunch

### 13.30 Error budgeting: geometric and thermal (cont.)

### 15.00 Break

### 15.30 Assessment of machine tool dynamic performance

- Introduction of basic dynamic considerations
- Measurement methods
- Measurement equipment
- Case study of modal behaviour

### 19.00 Course dinner

## Day 5

### 09.30 Case study design reviews

- Ultra precision machine evaluations

### 11.00 Break

### 11.30 Case study design reviews (cont.)

- Ultra precision machine evaluations

### 12.30 Open forum over lunch

### 14.30 Course ends

For more details about registration and accommodation please visit

[www.ultraprecision.org/courses/short-courses/](http://www.ultraprecision.org/courses/short-courses/)

## More information

### Course fee

£1,750. The fee includes tuition, course notes and materials, refreshments and lunches and the course dinner.

### Registration and accommodation

Accommodation is not included in the course fee. For details about registration and accommodation please visit our website: [www.ultraprecision.org/courses/short-courses/](http://www.ultraprecision.org/courses/short-courses/)

Short courses are subject to Cranfield University's booking terms and conditions. We reserve the right to amend published information.

### Contacts

#### Registration and accommodation enquiries:

[shortcourse@cranfield.ac.uk](mailto:shortcourse@cranfield.ac.uk)

#### General and technical enquiries:

[info@ultraprecision.org](mailto:info@ultraprecision.org)

