Gear Training

BRITISH GEAR ASSOCIATION

Promoting the technical and commercial interests of manufacturers, distributors, academics and others involved in the Power Transmissions industry in the United Kingdom.

The British Gear Association (BGA) are the leading providers of gear related training in the UK and Europe. All BGA training is developed and delivered by Gear experts from Academia and Industry.

From introductory classes to more in-depth specialist training we have all of your gear training needs covered. Our courses are suitable for all sections of the gearing world. From students and apprentices starting out in their careers to experts wanting to hone their skills or get up to date with the latest developments. Most of our training is CPD Accredited.

Thanks to the continued support of the BGA Membership we can **offer our online training to members completely free of charge** - non member fee £350 per delegate. If you are not a BGA Member please get in touch to find out how to join. In person courses are charged as stated in the course information.

Please go to the BGA website for course dates and registration **www.bga.org.uk/training**. If you would like to register for any of our essential gear training please contact the BGA office admin@bga.org.uk

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BGA Gear Training

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VIRTUAL GEAR FOUNDATION PART 1

Location: TEAMS
Tutor: Graham Penning

This introductory course is suitable and appropriate for anyone joining the gear industry. We have found this introduction to Gears to be beneficial not just to staff directly working with gears but also those such as HR and Sales departments to **ensure every member of your organisation a broad understanding of Gears and gearing.**

The course will not only equip the delegate with the basic gear knowledge to make a success of their career but also allow them to benefit from the more specialised seminars presented through the year in the BGA's Knowledge Transfer Programme.

This essential Gear training has been produced and will be presented by Gear expert Graham Penning over **three 2.5 hour session.** Each session will be completely interactive allowing delegates to ask questions and have them answered in a live environment.
Participating delegates will receive a certificate.

Session 1: An Introduction to Gears Part 1: Gear Fundamentals

Law of Gearing; The Involute Form; Power Transmission; Motion Control; Gear Types – Features and Benefits.

Session 2: An Introduction to Gears Part 2: Noise & Load

Modes of Failure (Bending, Pitting, Micro-Pitting, Scuffing, Wear) Gear Rating methods; Application Factors; Gear Lubrication; Noise & Vibration basics; Transmission Error.

Session 3: An Introduction to Gears Part 3: Gear Manufacture

Gear Material Specification; Gear Manufacturing Methods (Forming, Moulding, Machining; Hobbing, Shaping, Shaving, Honing, Grinding and Finishing); Heat Treatment and Gear Measurement.

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VIRTUAL GEAR FOUNDATION PART 2

Location: TEAMS

Tutor: Graham Penning

This introductory course is suitable and appropriate for anyone who has **completed Gear Foundation Part 1**. We have found this introduction to Gears to be beneficial not just to staff directly working with gears but also those such as HR and Sales departments to ensure every member of your organisation a broad understanding of Gears and gearing.

This essential Gear training has been produced and will be presented by Gear expert Graham Penning over three 2 hour sessions. Each session will be completely interactive allowing delegates to ask questions and have them answered in a live environment.
Participating delegates will receive a certificate.

Gear System Arrangements - Design and selection

Introduces the different architectures that can be used in gear systems and their features and benefits. Gives access to the basic formula for the preliminary design and initial sizing of gear systems. On completion of this module the student will be able to create different preliminary gear architectures for a particular application and select the most suitable

Gearbox Fundamentals - Design requirements and essential components

To give an understanding of the fundamental requirements of gearboxes and the essential components required to fulfil these requirements to the tooth forces present and developed by Involute Gear Teeth.

From this base the student will be equipped to;

Select and design the associated components of gears including.

- Bearings
- Shafts
- Couplings
- Seals
- Gearcases and supporting structures

Gear Lubrication Introduction

Introduce the fundamentals of Gear Lubrication and the surface conditions of gear teeth that occur during service. This will provide a foundation for the

- Proper selection of lubricants
- Design of lubrication systems
- Avoidance of scuffing and wear of gear teeth

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VIRTUAL GEARBOX SYSTEMS: PROBLEMS & SOLUTIONS

Location: TEAMS
Tutor: Jarek Rosinski—Transmission Dynamics

Duration: 2 3 hour sessions

Seminar Programme

Many reliability and wear problems in transmission systems are not directly associated with the design of the components themselves but are the result of system dynamics: starting and transient torques, self-excited vibration and the dynamics of the motor or engine and of the driven machine. Particular characteristics of bearings, couplings and gearbox mounting can also significantly affect system performance. Typical problems and solutions are discussed and instrumentation for troubleshooting noise, bearing failures, vibrations and in-service load measurement demonstrated.

The seminar will cover:

- Tackling Unexplained Bearing and Gear Element Failures
- The Dynamics of Gearbox Systems
- Gearbox Noise and Vibration
- Problem Solving using State of the Art Data Acquisition & Analysis Techniques
- Wind Turbine Gearboxes: Type Testing, Instrumentation & Early Stage Troubleshooting
- Gear Alignment Instrumentation ($K_{H\beta}$, K_{Y})
- In-Service Unattended Load (Torque) Data Collection Techniques
- Case Studies in Rail, Marine Propulsion, Renewables, Automotive and Heavy Industries
- State of Art Condition Monitoring Techniques

This is a live interactive session with plenty of opportunity to ask questions and interact with the tutor.

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VIRTUAL ATEX/DSEAR/NON ELECTRICAL EQUIPMENT ASSESSMENT

Location: TEAMS

Tutor: Louise Brearley - SGS / Baseefa

Post Covid and Brexit it is perhaps more important than ever to ensure you are up to speed with ATEX Certification.

We have collaborated with SGS Baseefa to create a bespoke ATEX course for BGA Members. The course is online and as we are using an external provider there is a fee which the BGA are subsidising, the whole day is only £100 per delegate for BGA Members.

1 Day Training Course For manufacturers/end users of Gear Drive Systems

In addition to the certification training Baseefas experts will also:

Make sure you are up to date with your ATEX obligations post Brexit .

Give the latest information no matter what the current situation is in March 2023.

Agenda

- Introduction
- The ATEX Product and Workplace Directive (including DSEAR) Module 1

Morning Break

- The ATEX Product and Workplace Directive (including DSEAR) Module 1 (continued)

Lunch

- Retrospective Ignition Risk Assessment (Existing/Old Equipment) Module 10
- Including topical discussions regarding generic gear drive designs/systems
- Components, Equipment, Assemblies & Protective Systems Module 30 (Understanding: 'Assembly' of 'Ex' Certified Equipment)

Afternoon Break

- Brief insight into the principles of EN 80079-36, -37 & -38 (formerly EN 13463 series)
- (Non-electrical equipment for use in potentially explosive atmospheres)
- Brief insight into a Non-electrical Technical File format (Including basic guidance pack)

Questions and Answers

Close

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VIRTUAL GEAR GEOMETRY

Location: TEAMS

Tutor: Rob Frazer —Design Unit / Newcastle University

This course is split into 4 sessions. The sessions will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 24 hours to run over things again if needed.

CYLINDRICAL GEAR GEOMETRY PART 1- HOW INVOLUTE GEARS WORK

Gear geometry is thought to be complex and often considered a 'black art'. This short on-line session will dispel this myth and provide delegates with a basic knowledge of how gears work and cylindrical gear geometry. No prior gear knowledge is required.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand what all the fuss is about.

The session will:

- Remind us why we use gears.
- Introduce us to the requirements of gears and the involute curve.
- Show how gears work.
- Show why gears need to be precise.
- Explain why gears are noisy and how we make them quiet.
- However, we wont look at gear design or gear calculations- that's for later sessions.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge: At the end of the seminar you will understand how gears work and understand what is important to make gears work properly. Designing, manufacturing and inspection processes make much more sense when you understand basic gear geometry. You will be ready to develop your knowledge further in the next gear geometry sessions from the BGA.

CYLINDRICAL GEAR GEOMETRY PART 2- AN INTRODUCTION TO BS ISO 21771:2007

Gear geometry is complicated, but this short on-line session will build on the part 1 of this series and introduce you to ISO 21771 on cylindrical gear geometry. The standard provides gear geometry calculations and is daunting, but this session will start your introduction to it, step by step.The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge.

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VIRTUAL GEAR GEOMETRY CONTINUED

The session will:

- Remind us how easy it is to specify gear geometry.
- Explain why it's more complicated in practice (spoiler alert- its due to how we make gears).
- Introduce us to ISO terms and more importantly to the symbols used in ISO gear standards. ISO symbols can be considered the international language of gears.
- Introduce some basic geometry calculations and diagrams from ISO 21771. We will show you how to interpret these.
- Include some basic gear calculations which require a scientific calculator.
- We will go through the answers at the end of the session.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge: Designing, manufacturing and inspection processes make much more sense when you understand basic gear geometry. You will be familiar with some common gear terms and symbols be able to understand and perform basic gear calculations with BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next gear geometry sessions available from the BGA.

CYLINDRICAL GEAR GEOMETRY PART 3- GEAR PAIRS AND THEIR RELATED GEAR GEOMETRY

This short on-line session will build on parts 1 & 2 of this series to develop your expertise and introduce you to profile shift coefficient, a subject that often causes confusion, gear pair geometry and tooth thickness calculations. The sessions will be based around ISO 21771:2007 standard and show you how to interpret the confusing gear pair drawings so you can confidently use the standard.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry. Many of us use commercial software or spreadsheets to perform gear calculations developed by others, but each of us needs to know what the values mean and where they come from.

The session will:

- Remind us how gears work
- Introduce gear pair geometry and lines of contact.
- Introduce the concepts of working pressure angle and show you how we work out where gears start to contact on the tooth flank.
- Introduce you to profile shift coefficient, 'x', why we use it, and what effects it has on gear geometry.
- Introduce you to basic tooth thickness calculations.
- Introduce the relevant geometry calculations and diagrams from ISO 21771.
- Allow you to test your knowledge with quizzes but don't worry, we will go through the answers

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VIRTUAL GEAR GEOMETRY CONTINUED

Key skills and knowledge:

Designing, manufacturing and inspection processes make much more sense when you understand gear geometry. You will be familiar with common gear terms and symbols be able to understand and be confident using gear calculations in BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next sessions available from the BGA looking at gear geometry that relates to gear performance.

CYLINDRICAL GEAR GEOMETRY PART 4- PERFORMANCE RELATED GEAR GEOMETRY.

- to contact on the tooth flank.
- Introduce you to profile shift coefficient, 'x', why we use it, and what effects it has on gear geometry.
- Introduce you to basic tooth thickness calculations.
- Introduce the relevant geometry calculations and diagrams from ISO 21771.
- Allow you to test your knowledge with quizzes but don't worry, we will go through the answers at the end of the session.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

Designing, manufacturing and inspection processes make much more sense when you understand gear geometry. You will be familiar with common gear terms and symbols be able to understand and be confident using gear calculations in BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next sessions available from the BGA looking at gear geometry that relates to gear performance.

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VIRTUAL INTRODUCTION TO ROLLING ELEMENT BEARINGS.

This online course is fully interactive with detailed examples and plenty of time for questions and discussion.

Bearings are an integral part of all mechanical power transmissions and rolling element bearings are often the most accurate component on the transmission. A good understanding of how they work is essential to those involved in transmission design, manufacture and assembly activities.

We will be examining both as run and damaged bearings which illustrate common failure modes.

The Seminar will cover:

- How rolling element bearings work and the history of their development.
- Common radial and thrust bearing types and their application, Benefits and limitations of each type pf bearing.
- Lubrication considerations.
- Calculation of bearing loads caused by the gears and discuss good design practice.
- Common bearing failure modes and an introduction to BS ISO 15243:2017 – Rolling bearings — Damage and failures — Terms, characteristics and causes.
- Basic bearing life calculation to BS ISO 281:2007 – Rolling bearings — Dynamic load ratings and rating life, for L10 life calculation and the modified life calculation Lmn considering endurance limit, lubrication and lubricant contamination. How do you use them?
- Miners sum cumulative damage analysis methods to account for varying load conditions.
- Examination of failed bearings and typical witness marks on bearings in service.

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VIRTUAL GEAR MEASUREMENT

This online course is fully interactive with detailed examples and plenty of time for questions and discussion. Please note this training is over **5 sessions** – you will need to attend all sessions to complete the course.

Cylindrical gear geometry measurement Part 1- Introduction to measurement methods and radial composite (double flank) measurement.

This is part 1 of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to measure and interpret gear measurement results. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand why you need to invest in precise gear measuring equipment. We will dispel the myth that measuring machines only produce scrap.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The session will:

- Remind us why we measure gears, failure modes that are influenced by gear geometry
- Introduce us to the requirements of gears and the involute curve.
- Introduce single element measurement (helix, profile, pitch and radial runout) and composite measurement (double flank and single flank) methods
- Look at double flank measurement in more detail including the measurement principles, equipment and ISO 1328-2:2020 tolerance parameters (they are different to earlier version of this document).
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session you will understand why we measure gears, the difference between the composite and single element measurement strategies and be familiar with double measurement principles, equipment and related ISO standards. Designing, manufacturing and inspection processes make much more sense when you understand what measurements will and won't do for you. You will be ready to develop your knowledge further in the next gear measurement sessions from the BGA.

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VIRTUAL GEAR MEASUREMENT CONTINUED…

Cylindrical gear geometry measurement Part 2- Introduction to tangential composite (single flank) measurement and tooth thickness measurement.

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to measure and interpret gear measurement results. It follows the previous introduction covered in part 1 of this session. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand why you need to invest in precise gear measuring equipment. We will dispel the myth that measuring machines only produce scrap.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The session will:

- Introduce single flank measurement in more detail including the measurement principles, equipment, and ISO 1328-1 tolerance parameters.
- Discuss the relationship between single flank measurement, Transmission Error (TE) and links to noise and vibration.
- Introduce fast Fourier Transforms (FFT) without any sums.
- Discuss the benefits and limitations of tooth thickness measurement methods.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session you will understand with single flank measurement principles, equipment and related ISO standard, and be familiar with tooth thickness measurement methods and good measurement practice. Designing, manufacturing and inspection processes make much more sense when you understand what measurements will and won't do for you. You will be ready to develop your knowledge further in the next gear measurement sessions from the BGA.

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VIRTUAL GEAR MEASUREMENT CONTINUED…

Cylindrical gear geometry measurement Part 3- Introduction to single element (helix, profile, pitch and runout) measurement

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to measure and interpret gear measurement results. It follows the previous session looking at single flank and tooth thickness measurement covered in part 2. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand why you need to invest in precise gear measuring equipment. We will dispel the myth that measuring machines only produce scrap.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The session will:

- Introduce single element measurement principles and equipment (CMMs and GMMs)
- Discuss the importance of gear datum axis definition for measurement.
- Ensure you are confident with results sheet formats.
- Look at good measurement practice- how to minimise the risk from common errors.
- Discuss the benefits and limitations of single element measurement methods.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session you will understand single element measurement principles and how we measure those tricky involute profiles, appreciate the different equipment options, and be introduced to good measurement practice. Designing, manufacturing and inspection processes make much more sense when you understand what measurements will and won't do for you. You will be ready to develop your knowledge further in the next gear measurement session from the BGA.

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VIRTUAL GEAR MEASUREMENT CONTINUED…

Cylindrical gear geometry measurement Part 4- Introduction to single element (helix, profile, pitch and runout) tolerance standards and how to interpret results to a standard

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to measure and interpret gear measurement results. It follows the previous session looking at single element measurement methods covered in part 3. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand why you need to invest in precise gear measuring equipment. We will dispel the myth that measuring machines only produce scrap.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The session will:

- Introduce ISO 1328-1:2013 cylindrical gear tolerance standard.
- Review some of the key features that were introduced with the latest revision.
- Discuss common errors when applying the standard.
- Work through an example to evaluate the ISO 1328-1 quality grade of a gear.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session you will understand single element measurement principles and how we measure those tricky involute profiles, appreciate the different equipment options, and be introduced to good measurement practice. Designing, manufacturing and inspection processes make much more sense when you understand what measurements will and won't do for you. You will be ready to develop your knowledge further in the next gear measurement session from the BGA looking at interpreting the cause of the measured deviations and assessing measurement performance later in the year.

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VIRTUAL GEAR MEASUREMENT CONTINUED…

Cylindrical gear geometry measurement Part 5- Introduction to gear measuring machine calibration

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to calibrate gear measuring machines. It follows the previous session looking at interpreting measurement results to a standard. You can only properly interpret measurement results if you know how accurate your measuring equipment is. Every day we are accepting gears which are outside tolerance and rejecting gears with are inside tolerance because of errors in the measurement process. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation, Introduction to Gear Geometry and earlier measurement online courses in this series.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand why you need to invest in precise gear measuring equipment.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The session will:

- Introduce common errors in measurement processes
- Demonstrate how we calibrate a simple hand-held micrometer
- Review the common sources of error in CNC gear measuring machines and CMMs with gear software
- Introduce the comparator method and ISO 18653:2003 Gears — Evaluation of instruments for the measurement of individual gears and related information in ISO TR 10064-1:2019
- Show you how easy it is to apply this standard and how you use the results to
- We have Included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session, you will appreciate that all measurement results are wrong, but some are useful. You will be able to assess the suitability of equipment for measuring your product gears and quantify the benefits from investing in new equipment. You will be ready to develop your knowledge further in the next gear measurement session from the BGA looking at interpreting the cause of manufacturing errors, we are currently planning.

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BRITISH GEAR ASSOCIATION

Promoting the technical and commercial interests of manufacturers, distributors, academics and others involved in the Power Transmissions industry in the United Kingdom.

VIRTUAL Design of Experiments (DOE)

Location: TEAMS
Tutor: Denis Sexton—DGS

Duration: 2 2.5 hour sessions

This online course is fully interactive with detailed examples and plenty of time for questions and discussion.

Why learn about DOE?

Properly designed experiments will improve

- Understanding of the Cause and Effect relationship in any process
- Predictive knowledge of the process, in order to improve it
- Control process costs, while meeting or exceeding customer requirements.

The course will cover:

- Background to DOE in understanding the cause and effect relationship
- Understanding data types, and the wide range of experimental tools.
- Planning an experiment (including gear measurement considerations)
- Determine if any factor or combination of factors is significant
- Screening trials and observations
- Replication and Repetition
- Statistical control and stability
- Analysis of Results via ANOVA and define prediction equations
- Process optimisation to reduce costs
- Case studies
- Software options

Module 1. Introduction to DoE Theory.

By the end of this module, the participant will:

- Understand the strategy behind Design of Experiments (DoE/DoX)
- Understand the types of experiments
- Understand the goals of an experimental strategy

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VIRTUAL Design of Experiments (DOE) Continued.

- Understand Coding
- Understand the limitations of One-Factor-At-a-Time (OFAT) experiments

Module 2. Methods of Data Analysis:

By the end of this module, the participant will:

- Understand the importance of control charts as analytical tools in DoE, and how to interpret them.
- ANOM, ANOR, and ANOME
- Understanding multi-level factors.
- Understand the concept of interaction.
- ANOVA for graphical and numerical analysis.
- Testing Results via “SPC for Excel®” and “Minitab®”
- General measurement issues.
- Evaluating the Measurement Process (EMP) studies

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VIRTUAL HEAT TREATMENT OF GEAR STEELS.

Location: TEAMS
Tutor: Philip Clarke

Duration: 2 2hour sessions

Seminar Programme

Philip Clarke will describe the heat treatment of gear steels assuming minimal prior knowledge. After an introduction to the basic metallurgical concepts and key principles, the enhancement of surface properties by carburising and induction hardening will be explained. The properties imparted by, and the consequences and problems of the chosen process with reference to material selection, distortion and growth will be covered with the aid of case histories.

The Seminar will cover:

- Introduction to steel heat treatment – metallurgical principles; hardening & tempering
- Carburising
- Introduction to nitriding, nitro-carburising & other surface treatments
- Laser & Electron Beam Hardening
- Induction & flame hardening
- Problem solving – low/high hardness; case-depth
- Controlling distortion

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IN PERSON - AN INTRODUCTION TO GEAR CUTTING AND MEASUREMENT.

Location: Various locations
Tutor: Martyn English
Fee: Member £1100 / Non Member £1550

The BGA **Introduction to Gear Cutting and Measurement** course is essential for engineers who want to broaden their understanding first principals of gear design and cutting.
Delegates will learn first principals of gearing and gain practical experience using our Maxicut 2A shaping machine and Sykes H150 hobbing machine. These manual machines will allow delegates to see the principals of gear design in reality giving a broader understanding of how the gear tools work.

Who should participate?
Engineers, technicians, supervisors, inspectors and setters who require an understanding and some practical experience in basic gear measurement and cutting. The course is designed for delegates who may have little or no prior knowledge of the subject but assumes that they are able to understand basic machine tool operations and trigonometry. The course is designed for delegates who may have little or no prior knowledge of the subject but assumes that they are able to understand basic machine tool operations and trigonometry.

By the end of the programme participants will be able to:

- Understand basic spur and helical gear theory and terminology
- Carry out basic calculations for the manufacture and measurement of gears
- Understand how spur and helical gears are cut by hobbing and shapingGain practical experience in setting up, producing and measuring gears made by hobbing & shaping
- Have a comprehensive set of notes and reference data

The programme will cover:

- Basic involute gear theory, terms and definitions for spur and helical gears including:
- Gear terms and definitions
- Introduction to the involute form and its construction/tables
- Calculations on the above
- Practical work on the measurement of gears including calculations on the following:
- Chordal tooth settings for gear tooth Vernier
- Constant chord settings to gear tooth Vernier
- Base tangent micrometer settings
- Distance over rollers measurement
- Basic principles of gear hobbing and shaping.
- Selection of index and feed change gears.

Practical work – setting up and producing spur & helical gears by hobbing and shaping using a *Maxicut 2A* shaping machine and *Sykes H150* hobbing machine

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IN PERSON - AN INTRODUCTION TO GEAR NOISE AND TRANSMISSION ERROR.

Location: Hexagon Manufacturing Intelligence - Nottigham
Tutor: Dr Michael Platten
Fee: Non Member £450 / BGA Member £250

This seminar is aimed at both gear users and gear manufacturers. Dr Michael Platten will examine the basic causes of gear noise and the path from initial gear design and manufacturing errors to the final noise generation.

Seminar programme:

Introduction
· The sources of Gear Noise
· Definition of Transmission Error (TE)

Gear Design for Low Noise
· TE and spur gears
· TE and helical gears
· The relation of TE to contact ratios and the concept of integer contact ratio
· Effect of misalignment on tooth contact
· Practical approaches to designing gears for low TE
· TE in planetary gears (theory of factorising and non-factorising)

Noise Signals
· Tooth passing frequencies
· Gear pairs
· Planetary gears
· Run out ; generation of side bands
· Ghost frequencies and their origin

Noise measurement
The practical aspects of noise measurement will be considered where in order to correctly diagnose the cause/source of the noise, it is necessary to correctly identify the frequency. Reference will be made back to the section on "Noise Signals."

Key skills and knowledge:
The student will be able to differentiate between actual gear noise problems and noise generated by other sources, identify the remedial action required to alleviate the problem and where to seek additional help if required.

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VIRTUAL GEAR STRESS ANALYSIS

Location: TEAMS
Tutor: Rob Frazer & Rob Lambert - Design Unit
Please note this training is over 4 sessions – you will need to attend all sessions to complete the course.

Cylindrical gear stress analysis – Part 1 Introduction to gear loads, failure modes and geometry

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to perform gear contact and bending fatigue stress analysis. The course covers the application of ISO 6336 bending and contact stress analysis methods. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, users of ISO 6336 and those who are involved with gear manufacture and want to understand why designers use tight tolerances and high grade materials.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The 1st session will:

Remind us how gears work, gear loads and load direction, what increases the instantaneous load as gear teeth mesh.

Define common gear failure modes.

An introduction to ISO 6336, the scope of the document and its key features.

The principle of how we calculate gear stress safety factors.

Selected terms and symbols- how the ISO symbol strategy works.

We have included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session, you will understand the challenge associated with predicting gear loads, how gears fail prematurely and the principles we use to calculate gear safety factors for contact and bending fatigue.

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VIRTUAL GEAR STRESS ANALYSIS CONTINUED

Cylindrical gear stress analysis – Part 2 Introduction to gear load modifying factors and permissible stresses for contact and bending fatigue

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to perform gear contact and bending fatigue stress analysis. The course covers the application of ISO 6336 bending and contact stress analysis methods. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, users of ISO 6336 and those who are involved with gear manufacture and want to understand why designers use tight tolerances and high grade materials.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The 2nd session will:

Focus on generic factors that influence the applied predicted load based mainly on ISO 6336-1

Load application factors and Miners Sum cumulative damage

Load dynamic factor

Accounting for shaft, bearing and housing deflections

Random manufacturing errors

Load distribution factors- key influences

The effect of micro geometry corrections on load

Review permissible stresses- options in ISO 6336-5.

We have included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session, you will understand the challenge associated with predicting gear loads, how gears fail prematurely and the principles we use to calculate gear safety factors for contact and bending fatigue.

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VIRTUAL GEAR STRESS ANALYSIS CONTINUED

Cylindrical gear stress analysis – Part 3 Introduction to gear contact stress and bending stress key influence factors

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to perform gear contact and bending fatigue stress analysis. The course covers the application of ISO 6336 bending and contact stress analysis methods. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, users of ISO 6336 and those who are involved with gear manufacture and want to understand why designers use tight tolerances and high grade materials.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The 3rd session will:

Introduce bending stress key influence factors

Show the effect from reverse torque loading and the effect on bending stress

Introduce contact stress key influence factors

Review example analysis results

We have included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session, you will understand the challenge associated with predicting gear loads, how gears fail prematurely and the principles we use to calculate gear safety factors for contact and bending fatigue.

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VIRTUAL GEAR STRESS ANALYSIS CONTINUED

Cylindrical gear stress analysis – Part 4 Introduction to using ISO 6336 and optimising bending and contact safety factors

This is part of a series of short on-line training sessions that will introduce delegates to the key skills and knowledge needed to perform gear contact and bending fatigue stress analysis. The course covers the application of ISO 6336 bending and contact stress analysis methods. No prior gear knowledge is required but those who are new to gear technology would benefit from participating in the BGA Gear Foundation and Introduction to Gear Geometry online courses.

It is applicable to gear designers, users of ISO 6336 and those who are involved with gear manufacture and want to understand why designers use tight tolerances and high grade materials.

The session will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 7 days to run over things again if needed.

The 4th session will:

Discuss

Minimum safety factors

Material quality

Case depth assumptions and requirements

Shot peening and residual stress

Contact marking- interpretation

Review some application examples and how to optimise ISO 6336 safety factors

We have included plenty of time for questions and discussion.

Key skills and knowledge:

By the end of the session, you will understand the challenge associated with predicting gear loads, how gears fail prematurely and the principles we use to calculate gear safety factors for contact and bending fatigue

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IN PERSON - GEAR WEAR AND FAILURE RECOGNITION

Location: Design Unit - Newcastle upon Tyne
Tutor: Brian Shaw & Chris Aylott
Fee: Non Member £450 / BGA Member £250

The seminar gives delegates an insight into the appearance and underlying causes of gear failure modes. No prior gear knowledge is required.

It provides gear manufacturers and users with the necessary skills to examine, assess and recognise common gear failure modes. The seminar content is applicable to gear designers, gear service personnel, operators and users of valuable equipment, inspection and certification bodies who need to confidently examine gears and gearboxes and those new to the gear industry.

The Seminar will cover:

- How gears work and how they fail and wear
- Failure recognition strategy
- An introduction to the common investigation methods and equipment used to establish the root cause of a failure
- An introduction to the ISO 10825 failure modes standard and supporting ISO standards
- Case studies
- Failure recognition- a chance to test your failure recognition skills with 20 failed gear samples

Key skills and knowledge:

At the end of the seminar you will be able to recognise the common failure modes, understand their causes and you will be able to confidently examine failed gears. You will appreciate what is considered normal wear and what could potentially be a problem and know the appropriate action to take.

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VIRTUAL GEAR NOISE DATA INTERPRETATION & DIAGNOSTICS

Location: TEAMS

Tutor: Jarek Rosinski—Transmission Dynamics

Duration: 2 2.5 hour sessions

Seminar programme:

Noise and vibrations are omnipresent, and while they may seem straightforward to interpret in some scenarios, industrial applications often introduce complexities that require a deeper understanding. This seminar explores the theoretical foundations of noise and vibrations, their sources, modes of transmission, and their implications for both systems and their surroundings. This seminar is designed to share the knowledge and tools necessary to interpret and diagnose noise and vibrations effectively in various industrial applications.

The seminar will cover:

- Principles of noise and vibrations
- Measurement techniques
- Understanding Gearbox Noise and vibrations
- Gear geometry, microgeometry and Transmission Error
- Gear design optimisation
- Rattle and Whine in gears
- Modal analysis and Modal shapes
- Data analysis and signal processing- time domain plots, FRF, FFT, Hilbert Transforms
- Case studies from a versatile selection of industrial applications

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VIRTUAL SURFACE INTEGRITY

Location: TEAMS

Tutor: Ronnie Rego —Instituto Tecnológico de Aeronáutica - ITA

Duration: 2 2.5 hour sessions

This online course is held over 2 sessions and is fully interactive with detailed examples and plenty of time for questions and discussion. Please note you need to attend both sessions to complete the course.

Seminar Programme

The objective of the training session is to offer the fundamental concepts of a surface integrity state in the light of gear design, manufacturing and testing. In Part I, the basic definitions of topography and residual stresses will be explored. Their manufacturing origins and influence on the fatigue behavior will be described. The material end with an introduction to residual stress assessment through X-Ray Diffraction (XRD). Centered in a “surface engineering” concept, these properties will be approached with a focus on the functionality of gears.

The session will cover:

- The concept of Surface Integrity;
- Topography: conventional and functional analyses of roughness
- Fundamentals of Residual Stresses: definitions, origins and influence on the fatigue behavior
- Introduction to X-Ray Diffraction (XRD)

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IN PERSON - GEAR MANUFACTURE

Location: Design Unit - Newcastle upon Tyne
Tutor: Paul Bradley
Fee: Non Member £450 / BGA Member £250

This seminar is aimed at engineers, technicians and individuals involved in gear specification/ procurement who wish to gain a sound overview of the manufacturing methods and process available to the gear designer or manufacturer. The seminar will cover not only the processes available but place some specific focus on the link between gear design and the production methodology.

This seminar is aimed at engineers and technicians who wish to gain a sound overview of the manufacturing methods and process available for the production of geared components.

The seminar will address all of the key methods of production covering casting, forming, moulding and cutting processes. Most all process commonly used to produce gears will be introduced but the principle focus will be placed on metal gear production produced by either cutting or grinding when looking at the detailed mechanics and production considerations.

Key Topics Covered within this seminar:

- Summary introduction of the range of gear production methods
- Summary of heat treatment and surface treatment methods
- Overview of process capability, selection and tooling requirements
- Detailed overview of the gear cutting and finishing processes of cylindrical gears

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VIRTUAL DESIGN AND PERFORMANCE RATING PROCEDURES FOR PLASTIC GEARS

Location: TEAMS

Tutor: Dr Damijan Zorko and Dr Borut Černe —RD Motion

Duration: 2 2.5 hour sessions

This online course is held over 2 sessions and is fully interactive with detailed examples and plenty of time for questions and discussion. Please note you need to attend both sessions to complete the course.

Seminar Programme

High performance plastic gears are increasingly replacing metal gears in several applications due to many advantages they exhibit. Main ones are having lower weight, no need for lubrication, cheaper mass production, significantly better noise, vibration and harshness (NVH) behavior and chemical/corrosion resistance.

Design methods for plastic gears are in many ways different and more complex to those for steel gears. In major part the complexity is to be attributed to the material's temperature-dependent properties. Also the production methods are different, which needs to be taken into account during the design phase. The majority of plastic gears are produced by injection molding, which enables great design flexibility, e.g. joining several machine elements into one molded part, as well as a wide range gear geometry modifications.

The course focuses on all aspects of the design process of gearboxes with plastic gears. The covered topics were selected based on what we experience during our work, working with our customers from automotive, micro-mobility (e-bikes), house appliances, aerospace, chemical, power tools and robotics sectors.

The seminar will cover:

a. Basic concepts on Plastic gears

- applications with plastic gears,
- available materials,
- design principles with aspect to production technology,
- production principles.

b. Overview of Plastic gear failure modes and design rating procedures

- possible plastic gear failure modes and conditions under which they occur
- comparison to steel gear failure modes
- highlighting the material properties required to conduct a comprehensive design rating procedure

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VIRTUAL DESIGN AND PERFORMANCE RATING PROCEDURES FOR PLASTIC GEARS CONTINUED ...

c. Methods for calculating the operating temperature of plastic gears

- presentation of available models and highlighting the most appropriate ones
- showcasing the correlation between the predicted temperatures and measured ones during gear operation

d. Fatigue performance

- explanation of the fatigue failure mode and different fatigue regimes (LCF, HCF, VHCF)
- methods to rate plastic gear design against the root fatigue failure mode,
- methods to rate the plastic gear design against the flank fatigue (pitting) failure mode,
- methods to improve the load-bearing capacity of plastic gears

e. Wear control,

- wear mechanisms and types of wear that can occur in plastic gear applications
- wear prediction methods
- methods to improve the wear performance

f. Gear quality

- overview of the gear quality parameters with a highlight on the ones having the most effect on the performance of plastic gears
- quantitative evaluation of quality effects on the gear performance and how to apply them in the design rating process (mechanical – effect on stress and thermal – effect on the operating temperature)

g. Lubrication (practical guidelines)

- pros and cons of applying a lubricant in a plastic gear application
- types of lubricants
- methods to select the best performing lubricant
- lubrication regimes for plastic gears

h. NVH

- sources of NVH in a gearbox,
- effect of wear and transmission error,
- NVH evaluation methods,

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VIRTUAL DESIGN AND PERFORMANCE RATING PROCEDURES FOR PLASTIC GEARS CONTINUED ...

i. Design principles for gearboxes with plastic gears

- selecting the appropriate tooth thickness and centre distance tolerance
- design principles for complete gearbox, once the detailed gear geometry is defined
- RD Motion's agile R&D process for design of gear transmissions with plastic gears

Topics and the lecture material are focused on practical applications, accompanied by a right measure of theoretical background.

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VIRTUAL INTRODUCTION TO BEVEL GEARS

Bevel gears play a crucial role in mechanical systems by enabling power and motion transfer between shafts that are not parallel. Even though they are fundamental components, the details of bevel gear transmission can be challenging to grasp, even for experienced engineers. This upcoming training session, spearheaded by experts Peter Wright and Fabian Sprenger, offers a unique chance to explore the fascinating world of bevel gears.

This “Introduction to Bevel Gears” training session is an invaluable resource for anyone eager to deepen their understanding of bevel gear technology. Participants will have the opportunity to dive into the intricacies of bevel gears during this in-depth online course.

Overview of the Course:

- Bevel Gears Types and General Applications
- Bevel Gear Classifications
- Fundamentals of Geometry
- Offset, Hand of Spiral & Direction of Rotation
- Face Milling – Face Hobbing Comparison
- Basics of the Continuous Indexing System
- Contact Pattern Development
- Tooth Contact Analysis
- Process of Design
- Calculation of Load Capacity
- Production Methods
- Measurement, Checking, and Assembly of Bevel Gears
- Failure Modes
- Optimisation

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