## UK Tribology Technical Committee:

**Chair:** Professor Robert Wood

**Members:** Professor Ian Hutchings, Professor Martin Priest, Professor Ian Taylor and Keith Harrison

## History of UK Tribology

Before 1966, the word ‘tribology’ was known only by a handful of individuals, among whom was the chairman Peter Jost, a mechanical engineer specialising in lubrication. His working group then published a report to the UK Parliament detailing the importance of friction, lubrication and wear, and crucially, its impact on the UK economy. It was within this report that the word ‘tribology’ was first used, and it has since become a respected field of science and engineering. Jost’s experience of tribology was largely in manufacturing, where he consulted with steel works to reduce the frequency of their machine breakdowns and improve machine efficiency.

Since then, tribology has spread beyond the manufacturing sector. With a push to reduce energy usage, tribologists have been given a vital role to play in reducing the parasitic losses in machines, whether through surface engineering, component design, material selection or lubricant formulation.

As tribology is a multidisciplinary field with such a wide reach, many UK-based institutions have formed tribology groups. In 2015, a new initiative to collaborate has been agreed to by the Institution of Engineering and Technology, Institution of Mechanical Engineers, Institute of Materials, Minerals and Mining, Institute of Physics and the Royal Society of Chemistry. These institutions have come together to form UK Tribology. The aim of this group is to encourage education, collaboration and interest in tribology, both for universities and industry. Knowledge of this subject will highlight the importance of proper tribological practice, which will ultimately lead to reduced energy usage and reduced economic loss. By collaborating, these institutions will bring together the greatest minds from each field, accelerating the development of new technologies to make the world run smoother.

## Aims of UK tribology

**Advancement in Interdisciplinary Areas:** Encouraging research and development in emerging fields such as nanotribology, biotribology, and 'green' tribology, which study friction, wear, and lubrication in various contexts including nanoscale, biological systems, and ecological aspects.

**Integration with Technological Progress:** Recognising the interlink between tribology and technological advancements, emphasising the importance of addressing tribological issues in various engineering sectors, including transport, energy generation, healthcare, agriculture, water supply, and beyond.

**Enhancing Understanding and Modelling:** Acknowledging the challenges in bridging the gap between atomistic and macroscopic scales in tribological phenomena and promoting collaborative research to improve the understanding and modelling of friction and wear processes.

**Education and Awareness:** Advocating for increased awareness and appreciation of tribological knowledge among engineers and management at all levels, highlighting the importance of incorporating tribological understanding into engineering education curricula.

## List of tribology research groups in the UK

Green tribology group, Bournemouth University

<https://www.bournemouth.ac.uk/research/projects/green-tribology-sustainable-design-lifeboat-launch-systems>

Dr Ben Thomas. thomasb@bournemouth.ac.uk

Tribology research group, University of Cambridge

<http://www-mech.eng.cam.ac.uk/Tribology/>

Prof John A. Williams. jaw@eng.cam.ac.uk

Sustainable systems and structures, Cardiff University

<https://www.cardiff.ac.uk/research/explore/research-units/tribology-and-performance-of-machines-structures-and-materials-research-group#:~:text=Tribology,fractal%20representations%20of%20surface%20geometry>.

Prof Carol Featherston. featherstonca@cardiff.ac.uk

Jost institute for tribotechnology, University of Central Lancashire

<https://www.uclan.ac.uk/research/activity/jost>

Prof Ian Sherrington. isherrington@uclan.ac.uk

Tribology group, Imperial College London

<https://www.imperial.ac.uk/tribology/>

Prof Daniele Dini. d.dini@imperial.ac.uk

Tribology group, University of Leeds

<https://eps.leeds.ac.uk/mechanical-engineering-research-functional-surfaces/doc/tribology/page/3>

Ardian Morina. a.morina@leeds.ac.uk

Dynamics & Tribology Research Group, Loughborough University

<https://www.lboro.ac.uk/schools/meme/research-and-innovation/research-groups/dynamics-and-tribology/>

Advanced Materials Research Group, University of Nottingham

<https://www.nottingham.ac.uk/research/groups/advanced-materials-research-group/research/surfaces-and-interfaces/surfaces-and-interfaces.aspx>

David Grant. david.grant@nottingham.ac.uk

Advanced Engineering Materials, NPL

<https://www.npl.co.uk/products-services/advanced-materials/surface-engineering-and-coatings>

Mark Gee. mark.gee@npl.co.uk

Leonardo Centre for Tribology, University of Sheffield

<https://www.sheffield.ac.uk/leonardocentre>

Prof Rob Dwyer-Joyce. r.dwyerjoyce@sheffield.ac.uk

National Centre for Advanced Tribology at Southampton (nCATS), University of Southampton

<https://www.southampton.ac.uk/research/institutes-centres/national-centre-for-advanced-tribology-at-southampton-ncats>

Prof Julian Wharton. j.a.wharton@soton.ac.uk

Tribology Research Group, University of Strathclyde

<https://www.tricorrnet.strath.ac.uk/website-tribos/home.htm>

Prof. Margaret Stack. margaret.stack@strath.ac.uk

Tribology Group, University of Sussex

<http://www.sussex.ac.uk/tribology/index>

Dr R. Glovnea. R.P.Glovnea@sussex.ac.uk

Precision Engineering and Surfaces Laboratory, University of Warwick

<https://warwick.ac.uk/fac/sci/eng/research/grouplist/measurement/precision/>

## Calendar of tribology events planned within UK

Materials Research Exchange (MRE) 2024. London, 23/04/2024-24/04/2024

<https://iuk.ktn-uk.org/events/materials-research-exchange/>

Electric Vehicle (EV) Tribology & Technology. 11/03/2024

<https://www.eventbrite.co.uk/e/electric-vehicle-ev-tribology-technology-tickets-778689199357>

TriboUK 2024 Conference. Southampton, 19/06/2024-20/06/2024

<https://tribouk.soton.ac.uk/>

2024 IEEE International Conference on Industrial Technology. Bristol, 25/03/2024-27/03/2024

<https://icit2024.ieee-ies.org/>

2024 IET 13th International Conference on Power Electronics, Machines and Drives. 10/06/2024-13/06/2024

<https://pemd.theiet.org/?utm_source=ieee&utm_medium=referral&utm_campaign=pemd>

Turbo Expo-Turbomachinery Technical Conference & Exposition. 24/06/2024-28/06/2024

<https://event.asme.org/Turbo-Expo>

STLE Tribolink, Leeds, 7-8th November 2024

[TriboLink 2024 - STLE UK Student Chapter (stleukstudents.org)](https://stleukstudents.org/tribolink-2024)

## What is tribology?

Tribology is the science and engineering of understanding friction, lubrication and wear phenomena for interacting surfaces in relative motion. It is highly interdisciplinary, drawing on many academic fields, including physics, chemistry, materials science, mathematics, biology and engineering. The fundamental objects of study in tribology are tribosystems, which are physical systems of contacting surfaces. Subfields of tribology include biotribology, nanotribology and space tribology. It is also related to other areas such as the coupling of corrosion and tribology in tribocorrosion and the contact mechanics of how surfaces in contact deform. Approximately 20% of the total energy expenditure of the world is due to the impact of friction and wear in the transportation, manufacturing, power generation, and residential sectors.

Friction is, by definition, the resistance to motion. The magnitude of this resistance is a function of the materials, geometries and surface features of the bodies in contact, as well as the operating conditions and environment. It is often desirable to minimize friction to order to maximize the efficiency of a component or process. Generally speaking, friction increases with load and surface roughness and can be decreased by the use of a lubricant.

Wear is the loss of materials, usually due to sliding. Typically wear is undesirable as it can lead to increased friction and ultimately to component failure. Like friction, wear is typically minimized by using a lubricant to separate the two bodies so that they do not directly touch one another.

Lubricants are primarily used to separate two sliding surfaces to minimize friction and wear. They also perform other functions, such as carrying heat and contaminants away from the interface. Lubricants are often liquids, typically consisting of oil and added chemicals, called additives, which help the oils better perform specific functions. However, there are some applications where lubricants can be gases or even solids.

There are several topics that are integrally related to the core areas of friction, wear and lubrication, but that deserve their own description. These are surface roughness, contact mechanics and nanotribology. Each topic will be briefly introduced here.

<https://en.wikipedia.org/wiki/Tribology>

<https://www.stle.org/files/About_STLE/Tribology/files/What_is_tribology/Tribology.aspx>

## Tribology and its impact on Net Zero

1. Booming energy prices

Due to the recent booming energy prices, demand for tribology expertise is steadily on the rise.

This should not come as a surprise, since an ASME (American Society of Mechanical Engineers) study indicates that energy savings through tribology research and development including turbomachinery, and industrial machinery and processes could well exceed EUR 46 billion per year.

Peter Jost, a British mechanical engineer who coined the term “tribology” estimated in 1966 that up to 3% of a developed country’s GDP could be saved by improved tribology practices. Moreover, he confirmed in a 1981 article on the subject that “16.25 billion USD per year could be saved by energy conservation through tribology”.

And in a more recent article of 2019, researchers concluded that recent advances in new materials, lubricants, and design changes could reduce energy losses by 18–40%, mainly resulting from friction and wear. In conclusion: increasing focus on tribology is a major low-hanging fruit in many industry applications.

2. Electrification

The automotive industry has long been specializing in tribology for its parts, lubricants and coatings, but also for its assembly lines. But in recent years industry has seen a rapid acceleration in the shift from internal combustion engines (ICE) to electric vehicles (EV).

While the shift from ICE to EV is bringing about major efficiency improvements through friction reduction of the bearings, this shift also brings in a whole new range of wear and friction challenges, not in the least related to the electric drivetrain: much higher rotational speeds, higher low-speed torque, and the added complication of electrical fields that may cause EDM (Electrical Discharge Machining) damage are major challenges to be solved before affordable and durable electric vehicles can become more mainstream.

A topic related to electrification is renewable energy through wind. This is also an industry that is seeing a growing demand for tribology research and testing, primarily to avoid premature failure of components to reduce maintenance costs, and an increase of their efficiency to increase energy output.

3. Industry 4.0

Increased automation through robotics has made tribology even more critical to manufacturing processes, since many types of sliding and rolling bearings are used in these processes. Friction is also a major consideration for robot designers.

As production automation is destined to continue on its current trajectory, there are also increasing opportunities for reshoring, as dependence on low-cost labour is reducing in relevance. An increase in demand for tribology specialists is bound to continue.

Another notable example is additive manufacturing, because the tribological properties of the materials that are used to make filaments for 3D printing or FDM (Fused Deposition Modelling) and on end-products produced by FFF (Fused Filament Fabrication) or SLS (Selective Laser Sintering) are as yet quite unknown.

4. The Circular Economy

Finally, environmental considerations are also increasing the importance of the tribology discipline: there is a whole new field emerging on the topic of making lubricants “natural” (bio-sourced) and/or biodegradable, or the tribological properties of environmentally friendly coatings.

This topic is growing in importance because there is an increasing societal desire to apply the principles of the circular economy and therefore taking a “cradle-to-cradle” approach to biochemical components. Tied to this is the need to increase life expectancy of consumer products. This also brings about an additional need for tribology tests.

Moreover, as manufacturers will shift their business model towards “product-as-a service” (take Rolls-Royce’s “power-by-the-hour” example as a best practice), they will have a growing incentive to improve product longevity, because products that last longer can be rented or leased for longer. Eco-design will be in their own interest, and planned obsolescence could soon become a problem of the past.

The discipline of tribology is an obvious area of focus for R&D departments that aim at extending product lifetime.

The transition to a carbon neutral, zero-emissions and digital European industry raises the stakes for Tribologists and tribology testing experts. Material suppliers, processing and manufacturing firms and coating specialists better start upskilling their CFO on the topic so that their firms start investing in additional expertise or partner up with specialists. Tribology will become no less than a hygiene factor for companies that want to win in a Green and Digital Europe.

<https://www.tribonet.org/news/general-topics/4-reasons-why-tribology-matters-in-the-net-zero-race/>

**Road Transport:**

Over the last 30-40 years, conventional petrol and diesel passenger cars have become much more energy efficient, resulting in the adoption of cars with a higher fuel economy. These more efficient cars have led to reduced fuel usage and lower CO2 emissions. However, much larger reductions in CO2 emissions can be achieved by moving to electric cars, although these will have separate tribological issues. There is now increasing awareness of the major contribution that road vehicles make to environmental pollution, both air- and water-borne, from dust generated from tyres and brakes – in both cases tribological issues.

**Healthcare:**

Tribology, the science of friction, lubrication and wear does not just address machinery issues. In the UK, with an aging population and with increasing child and adult obesity, there is a greater need for hip, knee, and other joint replacements, at substantial cost to the National Health Service. Replacement joints that have low friction and high durability not only increase the quality of life of the recipient but, by reducing the need for revision surgery, directly benefit the NHS. Other medical applications of tribology include low-friction catheters, stents, surgical masks/gloves, shaving and skin care products, contact lenses as well as oral healthcare products; learning from the plant and animal kingdom how friction, wear and surface fouling (biofilms) problems are solved there can potentially lead to environmentally friendly solutions with more widespread applicability. The UK has internationally recognized research groups in healthcare tribology.

**Space Sector:**

Tribology is also extremely important for space applications; there have been many examples where satellites have failed due to friction and wear issues. The space sector is one which the UK Government is keen to grow. At first sight, it is not clear that this is linked to Net Zero. However, the ability to monitor CO2 and methane emissions from space will help the UK Government demonstrate the impact of its policies on greenhouse gas emissions and monitor its progress, and that of other nations, towards Net Zero. Satellites play a key role in weather forecasting and timely information can mitigate the effects of adverse weather events.

**Wind Turbines:**

A key pillar of the UK’s electricity decarbonization journey is the widespread use of both onshore and offshore wind turbines. There have been significant tribological issues with wind turbines, most notably the failure of wind turbine transmission systems due to white etch cracking in rolling element bearings of the gearbox. Although wind turbines and the components within them are intended to have a design life of 20 years or more, some failures have occurred within a few years of commissioning. UK universities have been actively involved in research to better understand such tribological failures and to avoid them in the future.

**General Manufacturing:**

The UK is a global hub for advanced manufacturing, with the fastest manufacturing productivity growth in the G7 between 2010-2020 and in 2021 the UK was the world’s 8th largest manufacturing nation. The total value of UK manufacturers' product sales was £429.8 billion in 2022. The value of Surface engineering (just a component of the sector) to the UK was £11 billion for the SEAC industry affecting products worth over £140 billion. The tribology involved in manufacturing relates directly to the future of manufacturing and reducing costs to boost competitiveness. “Made Smarter”, via the digitalisation programme, and new materials/coatings and more efficient processes.

**Shipping:**

A particularly vital sector that will need innovation is maritime transport, and the transition to new, greener fuels to power vessels. Such fuels may include ammonia and/or methanol, which will pose challenges to the materials and the new lubricants needed for such engines; related issues include the management of NOx and unburnt ammonia, and what happens to internal engine components once the engine stops after steaming. The shipping industry is a critical element in the UK economy. Around 95% of British imports and exports in goods are moved by sea, including 25% of the UK’s energy supply, and 48% of the country’s food supplies. International maritime trade in 2018 contributed significantly to worldwide CO2 emissions.

**Aviation:**

Another key challenge in the transport sector is the greening of aircraft propulsion. Novel technologies are needed rapidly to realise electric and hydrogen-powered aircraft if they are to become mainstream in the 2030s. Handling hydrogen on aircraft and in other applications will also require expertise in cryogenic tribology and materials.

**Defence:**

The UK Government wants to promote greater ‘pull through’ of investment in research and development into deployable national security capabilities for the future while contributing to the UK’s strategic advantage through science & technology and thus it is focusing efforts to accelerate the research, development and exploitation of new technologies and capabilities. Applications where tribology skills are critical include armoured fighting vehicles, fixed and rotary wing aircraft, submarines, weapons, surface ships and UAVs.

**Sensors/Condition Monitoring:**

There are many opportunities and challenges for the use of sensors for monitoring machine condition, and for analysing the data from these sensors using machine learning and AI. In the future, many machines will be “smart” and connected to the internet, such that excessive energy use or imminent breakdowns can be highlighted to the users and the OEMs which can proactively address and prevent such issues. Again, the UK has many University tribology research groups that are working in this area.

**Lubricants/Lubrication:**

Many lubricant, grease and lubricant additive companies are based in the UK, and the sector is responsible for around 5,000 high value jobs. Lubricant companies are now making low viscosity energy efficient lubricants that help make machines save energy, and so indirectly they are responsible for reducing energy usage and CO2 emissions. Lubricants that reduce wear and extend machine life also help to spread the initial CO2 emissions expended in manufacturing that machine over a longer time. Extending the lifetimes of machines again impacts overall energy usage and CO2 emissions. The industry is now focusing on the more widespread use of recycling and re-using of lubricants to make new base oils, and also on bio-based lubricants. Lubricant companies are also working with sensor/condition monitoring companies to directly access information about the state of the lubricant and so better assess when oil changes are required – this leads to potentially less used oil waste and can help avoid expensive, unexpected, machine failures.

## Links to the tribology committees in institutions (g5) and STLE student chapter

Tribology research group, University of Cambridge

<http://www-mech.eng.cam.ac.uk/Tribology/>

Tribology group, Imperial College London

<https://www.imperial.ac.uk/tribology/>

STLE UK Student Chapter: <https://stleukstudents.org/>

## Jost funding (studentship and travel fund)

<https://www.jostfoundation.org/>

Travel fund application: contact either Professor John Williams: jaw@eng.cam.ac.uk , Professor Hugh Spikes: h.spikes@imperial.ac.uk or Professor H P Evans: pwtevans@gmail.com.#

## Upcoming tribology events

|  |  |  |  |
| --- | --- | --- | --- |
| IMechE | Vibrations in rotating machinery-virm 13 | 16 September 2025 | One Birdcage Walk, London |

|  |  |  |
| --- | --- | --- |
| TriboUK 2025 | TBD | Birmingham  |