

## Methodology

STLE's 2020 Report on Emerging Issues and Trends in Tribology and Lubrication Engineering study provides a fresh look into leading topics of concern for the field. This year, the study leveraged the expertise of STLE's Advanced Innovation Team (AIT), a group that updated the list of topics from previous STLE Emerging Trends studies, and over the course of several months, conducted a sweep of new and emerging issues in major segments of the field: transportation, energy, manufacturing and medical / health. The group then conducted 20 interviews with experts that hold specialized expertise in each area in order to refine, edit, and add to the list of topics for investigation.

The findings gathered by AIT were then submitted to the STLE membership and beyond through the execution of an electronic survey administered by McKinley Advisors, an association consulting firm, between August 15 and September 29, 2019. In total, 591 members of the field participated in the survey, representing 48 countries. The findings from the survey were evaluated by the AIT and presented back to the interviewed experts for their feedback. Their attributed quotes and remarks are found throughout the report.

## Executive Summary

STLE's 2020 Report on Emerging Issues and Trends in Tribology and Lubrication Engineering is divided into three separate, but important, topics related to the field. The first section, Application Sectors, provides an evaluation of leading trends in the four areas where tribologists and lubrication engineers focus their work (i.e., transportation, energy, manufacturing, medical / health). Each section provides a review of the current state of major trends and technologies, coupled with results from the survey that indicate the perspective of respondents towards how each trend will continue to develop in the future.

The second section, Field Issues, provides a focus on cross-cutting areas that impact the work of tribologists and lubrication engineers. These include an examination of the health of the workforce, the cost and availability of materials, and government regulations. Finally, the report concludes with a third section, Future Outlook, that predicts the tribology and lubrication field is well positioned to contribute to the growing desire for sustainability that spans all application sectors.

Key findings related to the application sectors and field issues are described below.



**Transportation:** Representing 57% of the market demand for lubricants, the transportation sector has enormous impact on the tribology and lubrication field. Over the past several decades, global and national regulatory pressures aimed at curbing emissions and improving fuel economy have resulted in a rapid pace of development in the sector. This trend is anticipated to continue, spurred along by new regulatory frameworks in the European Union, China, and other locations. While technological developments have improved the performance of traditional internal combustion engines, in part through the use of lower viscosity motor oils, much of the anticipated changes of the future are predicted to result from electric vehicles

(hybrid, plug-in hybrid, and pure electric), fuel cell development, and autonomous vehicle technologies. However, improvements in several related technologies and increases to the electric grid are required for these technologies to truly take off.



**Energy:** The production, use, and storage of energy is a chief concern to the world population, and much of the work of tribologists and lubrication engineers focuses on minimizing energy loss and improving production and storage capabilities. It is predicted that the worldwide demand for energy may grow by as much as 50% by 2050, necessitating not only greater levels of production, but also the continued development of enabling technologies for renewable energy capture. Wind and solar energy are predicted to lead the charge in the production of clean energy in the future, and both technologies have increased their energy generation capacity greatly in the recent past. However, advancements in their design as well as in energy storage will be required in order to support their continued development. In the interim, nuclear energy may offer a clean source of energy as a “bridge,” but is today hampered by public concerns.



**Manufacturing:** The manufacturing sector is undergoing significant changes due to the continued development of robotics for automation, additive manufacturing (also known as 3D printing), and because of developments in related sectors, such as transportation. For example, while the movement from traditional internal combustion engine (ICE) automobiles to electric cars will result in the need for less metalworking fluids and oils, it will also require new types of greases and heat transfer fluids. Advances in manufacturing are driven by cost and efficiency concerns that are occurring at a rapid pace due to the availability of new technologies developed in the manufacturing sector and other parts of the economy. For example, advances from the technology sector in the area of artificial intelligence will allow machines to make rapid decision-making that will optimize performance and minimize maintenance. These and other changes will require tribologists and lubrication engineers to adapt and learn about new products / outputs as well as process and operations concerns.



**Medical / Health:** A small panel of experts evaluated a series of trends related to tribology in the medical and health sector. Today, tribology is being relied upon to solve complex challenges, such as increasing the lifespans of prosthetics (hip and joint) or improve lubrication on surfaces, such as in the case of contact lenses. Tribology in this context faces several unique challenges, including smaller tolerances for error as well as greater difficulty in gathering data and evidence to advance the science. Participants in the study noted multiple advances that may be possible in the future, including unique applications for additive manufacturing that may allow for the production of highly specialized and custom tissues as well as more advanced prosthetics that can meet the increasing demands of an aging population.



**Workforce Issues:** Similar to previous iterations of the STLE Emerging Trends Research, respondents expressed concern that while there is an aging workforce in tribology and lubrication engineering that will need to be replaced, opportunities to do so are declining. Participants in the study noted that academic programs that provide education in the discipline are limited, perhaps by lack of research funding opportunities and diversion of resources into emerging fields. Moreover,

many engineers and scientists that do enter the field may be challenged to identify resources and opportunities for ongoing training and professional development.



**Research Funding:** The availability of funds and resources to support advances in research has implications for advancements in tribology and lubrication engineering as a whole. Often times, funding is linked to regional government or business interests, and is connected to some outcome such as increased productivity or elimination of a barrier (e.g., the problem of storing solar and wind generated energy). Emerging Trends Research participants prioritized several areas that they believed will garner the greatest amount of interest in the coming years, including batteries, additive manufacturing / 3D printing, innovative surfaces, recyclable materials, and advanced manufacturing. While batteries offer the potential for enormous impact on the energy and transportation sectors, new advanced manufacturing techniques such as additive manufacturing will lead to cleaner and better methods of production.



**Materials Cost and Availability:** Tribologists and lubrication engineers participating in the Emerging Trends Research expressed concern over a variety of factors related to the cost and availability of materials for lubricants. Chief among these was the general security of the supply chain, which can be unreliable due to its complexity (i.e., the number of companies, continents, and networks involved), as well as tariffs, regulations, industry consolidations and closures, natural disasters, and other factors. Research participants also indicated concern over the availability of specific resources, such as lithium, biocide options, rare earth metals, Group I base oils, and cobalt. Shortages in these materials have resulted in a push to find alternatives.



**Safety, the Environment, and Basic Human Needs:** Much of the work of tribologists and lubrication engineers relates to supporting basic human needs and improving lives. This is evident in the trends that surfaced elsewhere in the report, including increasing efficiency, energy reduction, and sustainability. Participants in the Emerging Trends Research rated a list of topical areas that related to safety, the environment, and basic human needs. The themes that emerged were a growing sense of urgency around energy efficiency and reducing air pollution and emissions. However, issues such as reducing industrial waste and water, an increasingly stressed resource, were also priorities. Tribology and lubrication engineering will continue to play an important role in solving these critical issues.



**Government Regulation:** Several government regulatory frameworks were evaluated by STLE Emerging Trends Research participants, including broad geo-locational regulatory structures and specific regulations targeted at materials and substances. For tribologists and lubrication engineers, the primary impact occurs when additives or lubricants are limited in use, either locally, regionally, or even globally. Participants in the study felt most strongly that there would be growing interest in regulations towards lead, chlorinated paraffins, nonylphenol ethoxylates (NPEs), phosphorus compounds, and zinc. As a result, the field continues to switch to alternatives while balancing the needs of performance and efficiency.