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An Overview of Forensic Engineering

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Commentary

Forensic engineering has been characterised as "the study of failures ranging from serviceability to catastrophic" that may result in legal action, both civil and criminal. It entails the analysis of materials, goods, buildings, or components that fail or do not work or function as intended, resulting in physical harm, property damage, or economic loss. Failure may give rise to action under either criminal or civil law, including but not limited to health and safety legislation, contract and/or product responsibility statutes, and tort law [1]. The topic also deals with retracing processes and procedures that result in automobile or machinery accidents. In general, the goal of a forensic engineering inquiry is to identify the reason or causes of a failure in order to improve the performance or life of a component, or to aid a court in ascertaining the facts of an accident [2]. It may also entail investigating intellectual property disputes, particularly patents. Forensic engineers in the United States must hold a professional engineering licence from each state. The field of forensic engineering has evolved in tandem with the field of engineering. Investigations of bridge failures such as the Tay rail bridge tragedy in 1879 and the Dee bridge disaster in 1847 were early examples. Many early train accidents encouraged the development of sample tensile testing and fractography of failed components.

The process of examining and collecting data linked to failed materials, goods, structures, or components is critical in the subject of forensic engineering. Inspections, evidence collection, measurements, model development, getting exemplar items, and experimentation are all part of the process. Testing and measurements are frequently carried out in an independent testing laboratory or another reputable unbiased facility. In the domain of safety engineering, failure mode and effects analysis (FMEA) and fault tree analysis approaches similarly evaluate product or process failure in a structured and methodical manner. All of these strategies, however, rely on accurate reporting of failure rates as well as precise identification of the failure types involved. Forensic science and forensic engineering share several similarities, such as scene of crime and accident investigation, evidence integrity, and court appearances. Both fields, for example, make substantial use of optical and scanning electron microscopes. They also use spectroscopy (infrared, ultraviolet, and nuclear magnetic resonance) to investigate key evidence [3]. Before destructive testing, radiography utilising X-rays (such as X-ray computed tomography) or neutrons is also highly useful in evaluating thick products for interior problems. A simple hand lens, on the other hand, can often indicate the source of a problem.

Trace evidence can be useful in recreating the chain of events in an accident. Tire burn imprints on a road surface, for example, can be used to estimate vehicle speeds, when brakes were applied, and so on. Ladder feet frequently leave a trace of the ladder's movement during a slip and may reveal how the mishap occurred. When a product breaks for no apparent cause, SEM and Energy-dispersive X-ray spectroscopy (EDX) in the microscope can reveal the presence of aggressive substances that have left traces on the fracture or neighbouring surfaces. As a result, an acetal resin water pipe junction failed unexpectedly, causing significant damage to the structure in which it was located. Traces of chlorine were found in the joint, indicating a stress corrosion cracking failure mode [4]. The above-mentioned broken fuel pipe junction revealed residues of sulphur on the fracture surface from the sulfuric acid that had begun the crack. Physical evidence may be extracted from digital photographs, which is a common technique in forensic accident reconstruction. Camera matching, photogrammetry, and photo rectification techniques are used to generate three-dimensional and top-down images from two-dimensional photos obtained at an accident scene. As long as images of such evidence are available, overlooked or unreported evidence for accident reconstruction can be collected and quantified. "Lost" evidence can be recovered and precisely determined by using images of the accident scene, including the car. When diesel fuel gushed out of a van onto the road due to a broken fuel pipe, a serious accident occurred. When a following automobile collided with an oncoming lorry, the driver was gravely hurt.

SEM revealed that the nylon connector had split due to Stress Corrosion Cracking (SCC) caused by a tiny leak of battery acid. When exposed to sulfuric acid, nylon is prone to hydrolysis, and a tiny leak of acid would have been enough to cause a brittle break in the injection moulded nylon 6,6 connector by SCC [5]. The majority of production models will include a forensic component that detects early failures in order to improve quality or efficiency. Forensic engineers are used by insurance firms to prove responsibility or non-liability. Most engineering disasters (structural failures such as bridge and building collapses) are investigated forensically by engineers trained in forensic methodologies. Forensic engineers investigate rail crashes, aviation accidents, and some automobile accidents, particularly when component failure is suspected. Furthermore, appliances, consumer products, medical devices, constructions, industrial machinery, and even simple hand tools such as hammers or chisels may be subject to investigations in the event of an injury or property damage. Because the failure of medical equipment is frequently life-threatening to the user, reporting and analysing them is vital. The body's ecology is complicated, and implants must both thrive and not drain potentially hazardous contaminants. Breast implants, cardiac valves, and catheters, for example, have all been linked to complications. Failures that occur early in the life of a new product provide critical information to the maker in order for the product to be improved. New product development seeks to remove flaws through factory testing before to introduction, however some may arise throughout the product's early life.

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