

Electrical Issues in Engineering Ethics and Solutions : A Compilation of Cases

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ABSTRACT

Engineering Ethics is a growing concern, especially as interest in public and industrial safety increases. The knowledge of Engineering Ethics acquired by Engineering students in the Colleges and Universities is not sufficiently enough to prepare them to handle safety challenges in the industry as pupil Engineers. Knowledge of Engineering Ethical issues, and how there were solved is very crucial on perspective of industrial and public safety. The purpose of this project is to identify issues in Engineering Ethics, what caused the problem (s), and the solution strategy employed in solving the problems. A collection of different failed Engineering projects in the field of Electrical Engineering are compiled. It is observed that majority of the catastrophic failures, most of which could have been avoided, were directly attributed to poor ethical decisions or practices. Most of the failure cases found in the study were at the consumer level- the demographics affected by these failures is more diverse and potentially more vulnerable than that of a large scale disaster. The majority of the consumer goods related to these cases were attributed to poor materials used to manufacture them, as well as lack of proper quality tests and validation through field experimentation. Some of the failures were catastrophic, and resulted in large scale damages. This paper, therefore, highlights the dangers of lack of proper ethical practices in Electrical Engineering, and further reveals the need for proper ethical practices and decisions.

Keywords : Safety, Engineering Ethics, Failures, Decisions, Fire, Maintenance.

I. INTRODUCTION

The Engineering Ethics is the study of moral issues and decisions that apply to the practice of Engineering. It examines and sets the obligations of Engineers to the society, to their clients, and to the profession. This paper identifies issues in Engineering Ethics, what caused the issues, and the solutions employed. The paper is a compilation of different Ethical issues in Electrical Engineering. The paper attempts to highlight the need for Engineering policy makers to closely sentinel people, institutions and corporations involved in technological activities for professional Ethical practices. This way, Engineers should hold paramount the safety, health and welfare of the public in the performance of their professional duties. This paper serves as a silent reminder to Engineers on the need to

build their professional reputation on the merit of their services. Engineers shall act in such a manner as to uphold and enhance the honor, integrity and dignity of the profession.

This paper is organized as follows: In section II, the Electrical issues in Engineering Ethics are presented. In section III, the conclusions are presented.

II. ELECTRICAL ETHICAL CASES

S/N	The Situation	Ethical Issues	Ref
1	GM recalled 32000 vehicles for repair due to faulty windshield wiper motor.	The motor of a Windshield wiper overheating due to poor design causing electrical short that could cause the wiper	[1]

		motor to catch fire.	
2	Coby Electronics recalled 19,600 rechargeable batteries sold with portable devices. Date: 2009	The rechargeable batteries were flawed in design and could overheat and cause a fire. Coby Electronics reported 8 cases of property damage from fire as a result.	[2]
3	Sayano-Shushenskaya Hydroelectric Power Station Accident.	Plant maintenance was ignored leading to severe plant vibrations. It was eventually put under full load despite vibrations and known issues. The turbine exploded, resulting in fires and power loss.	[3]
4	Soyuz 11 was the first successful visit to the world's first space station, Salyut 1. However the mission ended in disaster when the crew capsule depressurized, killing all crew.	A design flaw in the ejection of the descent module caused a breathing ventilation valve that resulted in the death of all of the crew members. The redesign of the next module allowed only two astronauts so that they could be fully suited during launch and landing.	[4]
5	Dell's laptop battery exploded leading to factory recall. Dell's poor laptop battery design contributed to property and personal injury.	Dell recalled 4.1 million laptop batteries because the battery had the potential to short internally and explode, starting fires and injuring people. Someone was injured and there were many reports of property damage.	[5]
6	In 1967, Apollo 1 was the first manned mission to the moon - but the command module caught fire during launch, killing the crew.	Upon investigation, several electrical arcs and power failures were discovered. After investigation, there were heavy modifications to future engineering designs, manufacturing, and quality control.	[6]
7	A court case resulted in the study, discovery, and recall of certain Toyota engine	The throttle control code within the engine control module could cause the vehicle to accelerate out of control, even a single	[7]

	control modules.	bit flip could trigger such an event.	
8	2 million vehicles were recalled due to faulty airbag systems.	The airbag electrical control module would receive interference from the vehicle and trigger an airbag deployment at any time, without a crash.	[8]
9	Toyota recalled about 6.5 million vehicles due to the power window master switch.	The power window master switch short-circuiting, resulting in the melting of the switch and burning of the door panel. Several cases of minor damages resulted. Recall was initiated to prevent further injury or fire from occurring.	[9]
10	Therac-25, was a computer based radiation machine that overdosed patients at least 6 times in a course of two years.	Therac-25 system relied on circuitry to protect against faults and prevent overdosing. Fault developed in the safety circuitry leading to the overdosing of some patients.	[10]
11	Federal Pacific residential circuit breaker panels failed to trip causing fires.	220V circuit breakers have manufacturing error. This caused the breakers to fail to trip under excessive load causing fire in most homes.	[11]
12	Flight MD-11 flying from New York to Switzerland crashed in the Atlantic. All passengers on board died.	Investigations revealed that arcing caused a wire to melt, setting fire on the insulation, which ignited flammable materials on board. The engineers failed to use very efficient over current protection relays. This prompted the FAA to increase its standards for flammable materials. US Navy got rid of similar wiring in their systems.	[12]
13	Flight 800 combusted in midair, killing all 230 of its	Despite a history of fuel system issues, maintenance men overlooked the habitual	[13]

	passengers. It had been previously inspected and had some of its issues ignored for the sake of it to continue flying.	issues. There was also a poor ventilation system for fuel vapors. Between these two issues, when a high voltage line shorted to one of the low voltage lines that go into fuel tanks, it created a spark that caused the plane to explode. It is speculated that poor wire maintenance and wire routing designs led to this issue.	
14	Chevrolet recalled the ignition switches in its 2010 Chevy Cobalt model car as well as in other models that fell within the model and time frame.	The ignition was poorly designed and the excess weight of a key ring or jarring of the vehicle could cause it to switch from the run to the accessory position. The engine would shut down, causing loss of power and the degradation of steering. The airbags would not deploy without the engine ON. This problem could have been avoided had the switch been better designed and a redundancy installed for the electrical system to deploy the airbags in the vehicle is in motion.	[14]
15	EDI Solar Panels recalls its solar panels from 2012 to 2013 due to the potential for electrical shock.	This product was designed with internal circuitry problems that have the potential to cause fire outbreak, and other issues.	[15]
16	Short circuit problem due to faulty circuitry in Fluke 116 meter, with the potential to cause fire or arc explosion.	The continuity beeper internal to the meter has design fault that could potentially dismantle and cause short circuiting inside. There were no injuries reported but the potential for them exist. The design team should have tested the beeper for integrity and recognized the danger with a moving metal part within a measuring	[16]
		device rated for 600V.	
17	Poor circuit board assembly could result in false readings on Fluke 37A clamp meters.	The Fluke 37A meter has connection problem with the board and the input jack for the test lead. This could result in no voltage condition on a live circuit and could injure someone with electrocution. Failure to field-test and error in manufacturing design issues were the ethical issues in this instance.	[17]
18	Users of LG Electric Ranges are urged to discontinue use after the wiring issues prevent the units from powering off.	There were 42 reports of the range failing to turn off after the switch was placed in the OFF position. This is very dangerous for the consumer and exhibits poor ethics on the engineers' part for failing to ensure the device was safe for use.	[18]
19	Cargo door on DC-10 aircraft bad design causes door to open allowing a quick decompression of cargo area and leads to crash of plane.	Senior engineer knew of the possibility of the problem and informed senior management of the situation. This problem was ignored because of redesign cost until crash occurred.	[20]
20	Breakthrough in organic material in place of silicon in the manufacture of semiconductors turns out to be false.	Bell Labs supposedly created semiconductors that use organic materials in place of silicon materials, which turned out to be a lie told by the engineer after receiving many awards for the work.	[21]
21	WakaWaka Electrical Adapter Kits can overheat and catch fire or expose components, creating a shock hazard.	WakaWaka recalled 900 total electrical adapter kits sold in North America. The adapter kits convert AC to DC voltage in a variety of connectors. The device was poorly designed or made of cheap materials and should have been thoroughly tested before selling.	[22]

22	A PNY portable lithium battery pack could vent flames during use, posing a fire hazard to all users.	PNY recalled about 56,800 units after one portable lithium battery pack vented flames during use. There was only one report of venting and flames without injuries, but the defect could cause fires or injury. The defect was likely due to low quality batteries, or a design flaw in the battery.	[23]			when IBM stopped the use of these chips.	
				26	Big Lots ceramic heaters were distributed to the consumers with faulty insulation leading to fires.	Model No. FH107A has an issue with the product causing overheating and melting. There should have been more adequate testing on the product. An over current sensing device would have prevented this problem. There were 4 reports of the component failing.	[30]
23	GE recalled 33,500 heating and air conditioning units due to risk of fire.	During certain operating conditions, moisture can collect near electrical components, creating a short to ground. This short could result in arcs and a fire hazard. This design flaw could have been prevented if the unit had been tested thoroughly in a variety of conditions. There were only 3 reports of smoke or fire and some property damage.	[24]				
				27	A defibrillator known as the RIATA contained deadly flaws resulting in electrical failures or even random 'jolts' to the heart.	The RIATA model defibrillator contained two main flaws: internal wires can work their way out of their casings and the silicone coating on the defibrillator leads could potentially wear out. When the silicone wears, the device could short circuit. The company was slow to warn doctors about the lead problem.	[31] [32]
24	Amprobe recalled a meter that was faulty regarding its ability to safely measure voltages.	Amprobe released a digital multimeter rated for CAT III/IV. The meter however was released not meeting these standards. The purpose of standards is to establish a baseline for quality and allows engineers and developers to make quality decisions. A failure to meet standards is an unethical decision.	[25]	28	In 2012, BMW recalled 1.3 million vehicles world-wide to replace a battery-cable cover.	The battery cable cover inside the trunk of the vehicles was incorrectly mounted. The flaw could result in the vehicle failing to start, electrical malfunctions, or even risk of smoke/fire. One month earlier, BMW agreed to pay \$3 million in penalties for failing to report safety defects in a timely manner.	[33]
25	Pentium released a processor that had major errors in its calculations and it was utilized in many major corporations.	Intel was aware of the problem and replaced the subsequent chips. However, initially they required users of the flawed chip to prove its malfunction instead of replacing them without question. They were aware of the issue and did not initially make it public. It would also seem that this replacement was brought to the table	[26] [27] [28] [29]	29	Lenovo recalled many of their laptop batteries due to the potential fire hazards and actual fire incidents the power supplies causes.	Lenovo released a product that was not fully tested in operating conditions. This is not safe and is unethical. In remedy of this issue however the company attempted to correct this mistake by offering free replacements of known faulty components.	[34]
				30	When Patriot Missiles Timing impacted an	There was a limit to the time estimate on this missile. As a result 28	[35]

	American encampment in Iraq, their software was called into question. It was found to be faulty.	American soldiers were killed. This is poor testing and cost lives. It also illustrated the improper training that accompanied the product and showed the need for constant software updates.	
31	ARIANE 5 rocket exploded costing European Space Agency (ESA) \$5 M	This issue was attributed to the software safety failing. The engineers failed to check the features	[36]
32	Bad electrical component on the control system failed to set off alarm.	The installers installed bad component on a ventilation control system preventing the alarm from coming on and causing the death of 100,000 chickens.	[37]
33	Horizon Hobby is recalling 1,300 E-FLITE battery chargers because they can overcharge batteries.	The charger could overcharge batteries and cause a fire, injury, or property damage. The charger should have included a feature that prevents batteries from being over-charged.	[38]
34	BSH Home Appliances recalled 194,000 dishwashers due to a fire hazard.	Wrong cable amperage used in the product, perhaps to cut cost. By using cheaper wires that were unable to handle the current, risk of fire hazards emerges.	[39]
35	Sensor not placed correctly.	Engineer incorrectly placed side air bag sensor on the TIBURON model inside the vehicle causing the sensor not to release air bag when crash occurs.	[40]
36	Defective unit on WHIRLPOOL dishwasher	Defective control board on the dishwasher causing fire and product failure.	[40] [41]
37	BMW Defective electrical fuel pump component.	BMW engineer's installed a defective fuel pump in their turbo model cars and then installed software to hide the problem. Complaints of sudden loss of power has put consumers at risk.	[42]
38	Lexus GS 350 Defective brake switch	A brake switch located on Lexus GS 350 a failing causing the car to start braking and potentially causing an accident.	[43]
39	GE Defective microwave	GE sold microwaves that have turned on by themselves and caught on fire. Reports filed have concluded that this was a known problem.	[44]
40	FORD Defective speed control module	Ford knowingly installed defective speed control deactivation modules within their vehicles as a result several fires have occurred.	[45]
41	Rober Bosch Tool Corp. is recalling 95,750 Dremel Micro tools for several reasons.	The tool's circuit board would overheat and melt the tool's casing, which could result in burns. Some tools could also lose their speed control and change to high speed during use, turn on during use, or not turn off at all. At this time, Bosch Tool received 6 reports of overheating tools without injuries. Bosch made the right move by recalling the tools before any injuries were inflicted. There were several flaws in the tool's design that could injure customers.	[46]
42	Ambient Weather recalled 12,500 radios due to fire hazards.	The AC adapter for the radio can overheat, posing a fire hazard. The company received three reports of fire and smoke in the battery-area of the radio, no injuries have been reported. This is likely due to cutting corners and using cheap materials in the AC adapters.	[47]
	Viking has expanded their recall of dishwashers to a total of 20,600	An electrical component inside the dishwasher can overheat creating a fire hazard. There were	[48]

	units.	over 136 reports of overheating connectors and 42 reports of fires with property damage (from both recalls). The faulty device was not thoroughly tested before sales.	
43	Instant Pot recalled 1,140 pressure cookers due to electric shock hazards.	The thermal probe in the base of the pressure cooker was shocking users. The finished product was not thoroughly tested, and no effective quality control.	[49]
44	The ORTHOVOX transceiver may not transmit an emergency beacon signal even when appearing to function normally.	The ORTHOVOX beacon transceiver is supposed to transmit an emergency signal in case an individual is buried in an avalanche. 3,000 units have been recalled with no reported injuries. The company did the right thing to recall the transceiver- it would have been unethical to sell a device that doesn't rescue people as promised. It's interesting that the device would appear to function normally even if it wasn't capable of transmitting a signal.	[50]
45	Failure of emission control system on certain Caterpillar engines.	The control systems on the c-13 and c-15 engines result in not meeting EPA standards. Caterpillar sold these motors knowing they do not meet standards.	[51]
46	Vornado Trust was forced to pay a \$500,000 civil penalty for failing to report defects and hazards in a product.	From 1993 to 2004, Vornado received over 300 reports of electric heaters overheating, melting, smoking, or even catching fire. They failed to report these incidents in a timely manner. Clearly the product was unsafe and the company should have issued a recall. It was unethical to not issue a recall after over 300 reports	[52]

		of the device overheating.	
47	LG has to pay the max penalty of \$1.825 million for failing to report defective humidifiers.	LG continued to sell the defective appliances from 2003 to 2009 and were finally recalled in 2012. The problem with the dehumidifier was a defective fan that caused the dehumidifier to overheat, smoke, melt, or even catch fire. It was unethical for LG to continue selling products with knowledge of potential harm to customers. LG was aware of 107 incidents by 2012, including \$7million in property damage.	[53]
48	Guidant LLC was formally convicted and sentenced for failing to report life-threatening defects in medical devices.	Guidant was ordered to pay more than \$296 million in criminal fines and forfeiture and submit to three years of supervised probation. The Justice Department charged Guidant for failing to notify the FDA about short-circuit failures in three models of its implantable defibrillators. Guidant was acting highly unprofessional and unethical. This resulted in three deaths.	[54]
49	In August 2015, Johnson Health Tech agreed to pay \$3 million in civil penalties for failing to report defective fitness equipment.	The Matrix Fitness Ascent Trainers and Elliptical Trainers were recalled in 2014. Moisture could build up in the power sockets of the units from sweat or cleaning liquids, which caused the machines to short circuit. The company received multiple reports of smoking, sparking, or melted power components and even reports of fires. Johnson Health Tech did not report defects or cases of injury within 24 hours, which was unethical on their part.	[55]

50	In 2009, HAIER America Trading LLC agreed to pay a civil penalty of \$587,500 for failure to report serious defects in one of their products.	According to the CPSC, HAIER knew that its Oscillating Tower Fans contained a wiring defect and posed a fire hazard, but failed to follow Federal law by reporting the defects in a timely manner. When oscillating, the wires can break after bending too many times. The risks include: fire hazard, burns, and electrical shock injuries. HAIER did not report the defective fans until the CPSC requested the reports. HAIER received 14 reports of the fans catching fire and one report of injury. HAIER acted unethically and could have prevented fires and injuries by reporting potential hazards.	[56]
	Polaroid Defective LCD TV	The TV has been causing fires since 2006 due to overheating. Users have been complaining, but the company did nothing.	[57]

III. CONCLUSION

In this paper, Ethical cases in Electrical Engineering is presented. The problems were identified, how the cases were resolved (in most cases) were indicated. It is noted that most of the Ethical violations resulted in fire outbreak, or at least burning. Common cause of fire being deliberate use of underrated devices or poor design materials as well as lack of proper quality tests-all in the bid to save cost, but at the expense of safety. The catastrophic failures, most of which could have been avoided, were directly attributed to poor ethical decisions or practices. This paper leaves one with the knowledge and conviction that every Engineer has a professional and moral responsibility. It is expedient to expose any questionable practice that will lead to an unsafe product or process.

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