

# Ethics omission increases gases emission: A look in the rearview mirror at Volkswagen software engineering

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The Volkswagen emissions scandal came to light in September 2015. The company installed software into millions of vehicles with diesel engines so that impressive emission readings would be recorded in laboratory conditions even though the reality is that the diesel engines do not comply with current emission regulations. Volkswagen is a worldwide organisation with its headquarters in Germany. Its subsidiaries adhere to common policies and a corporate culture. This worldwide scandal broke first in the US with ongoing investigation and legal action there and in other countries including Germany, Italy and the UK.

Combustion engines are the source of pollution and therefore have been subjected to emission control. The formation of NOx (nitrogen oxides) through combustion is a significant contributor to ground-level ozone and fine particle pollution which is a health risk. On this basis, the use of software to control emissions must be defined as safety critical for, if it fails or malfunctions, it can cause death or serious injury to people. There does not appear to be any acknowledgement of this across vehicle manufacturing.

The statement from the US Department of Justice<sup>1</sup> details the facts of the VW emissions case. Two senior managers, Jens Hadler and Richard Dorenkamp appear to be at the centre of the so-called defeat software's ongoing design and implementation processes. These began in 2006, with the design of a new diesel engine to meet stricter US emission standards to take effect in 2007. The goal was to market new vehicles as meeting the stricter standards and attract US buyers. Being unable to accomplish this, the engineers working under Hadler and Dorenkamp, developed software which allowed vehicles to distinguish test mode from drive mode thus satisfying the emissions test whilst allowing much greater emissions when vehicles were on the road. "Hadler authorized Dorenkamp to proceed with the project knowing that only the use of the defeat device software would enable VW diesel vehicles to pass U.S. emissions tests."

Drawing upon *the Statement of Facts*, Leggett<sup>2</sup> reported that whilst there had been some concerns over the propriety of the defeat software all those involved in the discussions including engineers were instructed not to get caught and furthermore to destroy related documents. According to Mansouri<sup>3</sup>, Volkswagen is an autocratic company with a reputation for avoiding dissent and discussion. It has a compliant business culture where employees are aware that underperformance can result in replacement and so management demands must be met to ensure job security. Three statements in particular in the *Volkswagen Group Code of Conduct*<sup>4</sup>; *Promotion of Interests*<sup>(ibid., p15)</sup>, *Secrecy*<sup>(ibid., p16)</sup> and *Responsibility for Compliance*<sup>(ibid., p22)</sup>, align with the ongoing conduct encouraged during the emissions debacle. Trope and Ressler<sup>5</sup> explain that as an autocratic book of rules, the group code supports and even promotes dishonest dysfunctional behaviour which includes the creation of software to cheat, rather than solve, engineering problems and to protect that software from disclosure as if it were a trade secret.

On 11 January 2017, the US Justice Department announced that, "Volkswagen had agreed to plead guilty to three criminal felony counts, and pay a \$2.8 billion criminal penalty, as a result of the company's long-running scheme to sell approximately 590,000 diesel vehicles in the U.S. by using a defeat device to cheat on emissions tests mandated by the Environmental Protection Agency (EPA)

and the California Air Resources Board (CARB), and lying and obstructing justice to further the scheme.”

## Business analysis

Many of the accounts about the Volkswagen emissions case focus on business ethics with only a few touching upon the role of the software engineers in this situation. These accounts at times are repetitive but intertwine to provide a rich view. The widespread unethical actions across Volkswagen can be described as a new type of irresponsible behaviour, namely *deceptive manipulation*<sup>6</sup>. The detail of this and the associated corporate repercussions are discussed further by Stanwick and Stanwick<sup>7</sup>.

Software engineers at Volkswagen faced ethical and legal issues that are easy to identify. Plant<sup>8</sup> suggests that they should have alerted external bodies since the internal lines of reporting were compromised. Merkel<sup>9</sup> concurs citing the *Software Engineering Code of Ethics and Professional Practice* (see <http://www.acm.org/about/se-code>) by way of justification, and adds that the lack of whistleblowers in such a large group is surprising. Both authors point to the potential personal cost of whistleblowing as the reason it did not happen. Rhodes<sup>10</sup> adds a second factor, arguing that corporate business ethics is very much a *pro-business stance* which is implemented through corporate control and compliance systems, and instruments of managerial coordination. This can enable the pursuit of business self-interest through organised widespread conspiracies involving lying, cheating, fraud and lawlessness. This is what happened at Volkswagen. Queen<sup>11</sup> concurs, explaining that Volkswagen intentionally deceived those to whom it owed a duty of honesty. The pressure for continuous growth and the perception that failure was not an option<sup>12</sup> created a culture where corporate secrecy was paramount which in turn implicitly outlawed whistleblowing.

## The role of software engineering

If one has a responsibility for the planning, design, programming or implementation of software then that aspect of one's work falls within the scope of the *Software Engineering Code of Ethics and Professional Practice* regardless of one's job title. In that sense software engineering pervades this debacle and is therefore worthy of further investigation.

So what was the role of software engineers in the creation and installation of VW's defeat software? This question can be addressed using the *Software Engineering Code of Ethics and Professional Practice*. The code is long established, documenting the ethical and professional obligations of software engineers and identifying the standards society expects of them<sup>13</sup>. The code translates ethical principles into practical guidance. It encourages positive action and resistance to act unethically. It has been adopted by many professional bodies and companies worldwide and has been translated into Arabic, Croatian, French, German, Hebrew, Italian, Mandarin, Japanese and Spanish.

Software engineers and software engineering educators have a responsibility to be cognisant of the code and its requirements. *Public Interest* is central to the code which is apposite for safety critical software. Although education can influence the courage and capability to act in accordance with the code, that result depends on structural and psychological supports within the environment in which engineers practice.

The actions of VW managers and software engineers violated the following principles of the code:

**Principle 1.03** “approve software only if they have a well-founded belief that it is safe, meets specifications, passes appropriate tests, and does not diminish quality of life, diminish privacy, or harm the environment. The ultimate effect of the work should be to the public good.” The defeat software is clearly unsafe given NOx pollution damages both health and the environment. The public were under the misapprehension that VW cars were emitting low levels of NOx and therefore not a health risk. Thus software engineers installed unethical software.

**Principle 1.04** “disclose to appropriate persons or authorities any actual or potential danger to the user, the public, or the environment, that they reasonably believe to be associated with software or related documents.” There is no evidence that any software engineer disclosed. Commercial software is usually developed in teams and in this case it is likely this was a large team spanning all aspect of software development.

**Principle 1.06** “be fair and avoid deception in all statements, particularly public ones, concerning software or related documents, methods and tools.” The emissions software was heralded publically as a success when internally there was widespread knowledge that this claim was fraudulent. Software engineers were likely to have been privy to this cover-up.

**Principle 2.07** “identify, document, and report significant issues of social concern, of which they are aware, in software or related documents, to the employer or the client.” There is some evidence that concern was raised about the efficacy of the defeat software but it seems those in dissent allowed themselves to be managed towards deception.

**Principle 3.03** “identify, define and address ethical, economic, cultural, legal and environmental issues related to work projects.” The EPA regulations are explicit and are legally binding. From the evidence accessed it is unclear as to whether software engineers knew of the illegality of their actions. Nevertheless ignorance cannot and must not be a form of defence.

**Principle 6.06** “obey all laws governing [the] work, unless, in exceptional circumstances, such compliance is inconsistent with the public interest.” This relates to the analysis under principle 3.03. Compliance to further the prosperity of Volkswagen was at the expense of legal compliance.

**Principle 6.07** “be accurate in stating the characteristics of software on which they work, avoiding not only false claims but also claims that might reasonably be supposed to be speculative, vacuous, deceptive, misleading, or doubtful.” Software engineers could argue internally that the software indeed performed as it was designed to. However, the design was to achieve regulatory and public deception.

**Principle 6.13** “report significant violations of this Code to appropriate authorities when it is clear that consultation with people involved in these significant violations is impossible, counter-productive or dangerous.” Given the apparent corporate culture within Volkswagen there was little point in reporting concerns further up the line. In fact the corporate code seems at odds with the professional code regarding this point. Software engineers failed to report these breaches to appropriate authorities.

## Conclusions

Professionals, who must have been party to this illegal and unethical act, developed and implemented this software. Those who undertake the planning, development and operation of

software have obligations to ensure integrity of output and overall to contribute to the public good<sup>14</sup>. The ethical practice of software engineers is paramount. Practice comprises process and product. Process concerns virtuous conduct of software engineers, whereas product concerns whether software is deemed to be ethically viable. Actions and outcomes in the Volkswagen case appear to have failed on both counts.

These serious issues related to professional practice need to be addressed. It is hoped such issues are exceptional but sadly it is likely they are commonplace given the ongoing plethora of software disasters (see, for example, Catalogue of Catastrophe<sup>15</sup> and Software Fail Watch<sup>16</sup>). Unethical actions related to software engineering can be addressed from two sides. One side focuses on resisting the temptation to perform unethical practice whilst the other focuses on reducing the opportunity of performing unethical practice. Society at large needs competent, ethical and altruistic professionals to deliver societally-acceptable, fit-for-purpose software. Both of these can be helped by education, but education will not suffice without adequate social supports.

In order to fulfil software engineering duties, an individual must fully understand the professional responsibilities and obligations of the role. These are explicitly laid out in the *Software Engineering Code of Ethics and Professional Practice* and as such individuals must know and apply it to their everyday work. To achieve this, the effective education of new professionals is essential. Teaching technology in isolation is unacceptable and dangerous. Software engineers need a broader education to gain the necessary skills and knowledge to act in a socially responsible manner not on the basis of instinct and anecdote but on rigour and justification<sup>17</sup>. They must possess practical skills to address the complex ethical and societal issues which surround evolving and emerging technology. Such education should be based on a varied diet of participative experiential learning delivered by those who have a practical understanding of the design, development and delivery of software. Contrasting the Volkswagen Group Code of Conduct with the Software Engineering Code might provide one means for experiential learning. Such educated software engineers might find ways to prevent the installation of unethical software of the future.

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