The EPA's Role in the VW Emissions Scandal

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Abstract

In 2014, a study[24] conducted by West Virginia University determined that several models of Volkswagen diesel car[15] produced emissions of Nitrogen Oxide at almost 40 times the legal limit[24]. It was discovered that Volkswagen took steps to mask the emissions of their cars during EPA testing[13]. Were EPA engineers in violation of the Software Engineering Code of Ethics? While the EPA should have designed better tests[20], it is impossible to guarantee that any test is immune to exploitation. This question deals with SE Code[16] tenets 1.03, 1.05, and 3.01. EPA staff were *not* in violation of the Software Engineering Code of Ethics because their actions were consistently in compliance with the Code.

Contents

1 Facts

A study[24] conducted by West Virginia University shows that several models of Volkswagen diesel cars[15] produced Nitrogen Oxide emissions at levels of almost 40 times the legal limit[24]. The results of this study were at odds with those of the EPA's emissions tests[24] on the same vehicles, which showed their emissions as being at acceptable levels. After these results had come to light, Volkswagen admitted[11] to installing a software mechanism in their diesel cars which would detect when the cars were being tested by the EPA. The cars would then optimize certain components of the engine cycle to reduce emissions, thus reporting results which were inconsistent with those that one would see under everyday driving conditions. Volkswagen was able to detect the track used by the EPA, as it is freely available to view[20]. Because Volkswagen knew the specifics of the test, they were able to use time-distance curves[13] coupled with a measure of atmospheric pressure to set a flag which would temporarily decrease the emissions of their vehicles until the testing conditions were no longer met.

2 Research Question

Were the the EPA's engineers in violation of the Software Engineering Code of Ethics?

3 Social Implications

Volkswagen's ability to cheat the EPA's emissions tests begs the question: Is the government an effective defender of human health? There are several examples of times when the government has failed to adequately regulate industry to the detriment of its citizens' health[17, 22]. In these cases, it is important to determine whether the shortcomings of government regulation originate in perceived needs, policy, implementation, or assurance[12]. To better understand what can be done to improve government's ability to protect the consumer, it is important to look at government's role in the failure. While it is not possible to fully protect a system from exploitation, there must be a determination made as to whether government expends an adequate amount of effort when designing and implementing tests. This determination is more important now then ever, as the auto industry faces a revolution that brings with it several moral questions[23].

4 Others' Arguments

4.1 Poorly Designed Tests

EPA engineers **were** in violation of the Software Engineering Code of Ethics. They violated the code by designing tests that were easy to exploit. It is their fault that VW was able to implement a defeat device to beat their tests[20].

4.2 VW Honesty

EPA engineers **were not** in violation of the Software Engineering Code of Ethics. Although their engineers failed to design tests that VW was incapable of beating, it was the responsibility of VW's engineers to remain honest. VW's engineers were the ones to violate the SE Code[25].

4.3 Too Much Transparency

EPA engineers **were not** in violation of the Software Engineering Code of Ethics. Because of legislation regarding transparency in the government, EPA engineers were required to release a large amount of information regarding the testing environment. EPA's engineers were not able to prevent VW from cheating, as legislation prevented them from doing so[25].

4.4 Too Little Transparency

EPA engineers **were not** in violation of the Software Engineering Code of Ethics. Because of legislation regarding transparency in the auto

industry, EPA engineers were not given the resources to adequately test automobiles for emissions compliance. VW's defeat device was more complex than EPA engineers were prepared or able to test for[13].

5 Analysis

5.1 How the SE Code Applies

5.1.1 Software Engineer

The Software Engineering Code[16] defines a software engineer as "[an engineer] who contributes by direct participation or by teaching, to the analysis,..., certification, ... and testing of software systems".

5.1.1.1 Contribute

Contribute is defined as "to give to a common supply"[2].

5.1.1.2 Direct Participation

Direct is defined as "proceeding in an unbroken line of descent"[2]. To proceed is defined as "to carry on or continue any action or process"[2]. Descent is defined as "derivation from an ancestor; lineage; extraction"[2]. Ancestor is defined as "an object, idea, style, or occurrence serving as a prototype, forerunner, or inspiration to a later one"[2]. . Participation is defined as "the fact[1] of taking part, as in some action or attempt"[2].

Direct participation can therefore be defined as "the fact of taking part, as in some action or attempt that is carried on in an unbroken line of derivatives of forerunners".

5.1.1.3 Analysis

Analysis is defined as "the separating of any material or abstract entity into its constituent elements"[2].

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[1]Not a typo

5.1.1.4 Certification

Certification is defined as "the act of guaranteeing or endorsing reliably"[2].

5.1.1.5 Testing

Testing is defined as "the means by which the presence, quality, or genuineness of anything is determined; a means of trial"[2].

5.1.1.6 Software System

Software is defined as "the programs used to direct the operation of a computer,..."[2]. A system is defined as "an assemblage or combination of things or parts forming a complex unitary whole". A software system can therefore be defined as "any assemblage or combination of things or parts forming a program used to direct the operation of a computer".

5.1.1.7 Software Engineer Definition

Using the definitions above, a software engineer can be defined as "an engineer who gives to a common supply by taking part, as in some action or attempt that is carried on in an unbroken line of derivatives or forerunners, or by teaching, to (1) the separating of any material or abstract entity into its constituent elements, (2) the act of guaranteeing or endorsing reliably, and (3) the determination of the presence, quality, or genuineness of any assemblage or combination of things or parts forming a program used to direct the operation of a computer".

5.1.1.8 Analysis

5.1.1.8.1 Software System

The EPA's engineers were tasked with measuring and certifying the emissions of VW's cars[20]. Therefore, their duties align with those stated in the definition of software engineer above, while the software on VW's cars were the systems being analyzed.

5.1.1.8.2 Summary

From our definition, we can see that the role of the EPA's engineers as software engineers was to break down the software running VW's cars and reliably endorse their quality and genuineness.

5.2 Tenet 1.03

5.2.1 Tenet

> 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.

5.2.1.1 Definitions

5.2.1.1.1 Approve Software

To approve is defined as "to confirm or sanction formally"[2]. Software is defined as "the programs used to direct the operation of a computer,..."[2]. Therefore, a general definition of approve software is "to confirm or sanction formally the programs used to direct the operation of a computer".

As defined above[2], the computers being tested were those running on VW's cars. Therefore, a domain specific definition of software approval is "to confirm or sanction formally the software controlling VW's cars".

5.2.1.1.2 Well-Founded Belief

A Well-Founded Belief is defined as a belief "that is based on excellent reasoning, information, judgment, or grounds"[4].

5.2.1.1.3 Safe

Safe is defined as "secure from liability to harm, injury, danger, or risk"[2].

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[2]5.1.1.8.1

5.2.1.1.4 Meets Specifications

To meet is defined as "to come upon; come into the presence of; encounter". Specifications are defined as "a detailed description or assessment of requirements,..., materials, etc., as of a ... machine, ..."[2]. Therefore, to say a machine meets specifications is to say that the design has "come into the presence of", or is aligned with, "a detailed description or assessment of requirements, materials, etc.".

5.2.1.1.5 Appropriate Tests

Appropriate is defined as "suitable or fitting for a particular purpose"[2]. A test is defined as "the trial of the quality of something"[2]. Therefore, appropriate tests can be defined as "trials suited to a particular purpose that measure the quality of something".

5.2.1.1.6 Quality of Life

Quality of Life[14] refers to a combination of basic human needs (food, shelter, etc.) and subjective well-being. Subjective well-being refers to individuals' or groups' perceived levels of happiness, satisfaction, etc. in regards to the degree to which their basic human needs are met.

In this case, Quality of Life will more specifically refer to the health-related aspects of basic human needs[14].

5.2.1.1.7 Harm the Environment

Harm is defined as "to do or cause harm to; injure; damage; hurt"[2]. The environment is defined as "the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time"[2]. Therefore, to harm the environment can be defined as "to damage the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time".

5.2.1.1.8 The Public Good

The public good is defined as "the well-being of the general public"[2]. Well-Being is defined as "a state characterized by health, happiness, and prosperity"[2]. General public is defined as "all the people in an area, country, etc."[4]. The public good can therefore be defined as "the health, happiness, and prosperity of all of the people in an area, country, etc.".

While no cars have zero environmental impact[26], there is a legal limit to the amount of emissions a vehicle produces before it is deemed work against the public good[19]. As defined above, the software systems being evaluated are those running the operations of VW's cars. A domain specific definition for the public good is "ensuring VW's cars produce emissions that conform to the governing standards for emissions".

5.2.1.2 Domain Specific Tenet 1.03

> An EPA engineer should formally sanction the software controlling VW's cars only if they have a belief based on excellent reasoning, information, judgment, or grounds that it is secure from liability to harm, injury, danger, or risk, is aligned with a detailed description or assessment of requirements, materials, etc., passes trials suited to a particular purpose that measure the quality of the software, and does not diminish the health-related aspects of human needs, diminish privacy or damage the air, water, minerals, organisms, or any other external factors surrounding and affecting a given organism at any time. The ultimate effect of the work should be to ensuring VW's cars produce emissions that conform to the governing standards for emissions.

5.2.1.3 Analysis

5.2.1.3.1 Excellent Reasoning, Information, Judgment, or Grounds

The judgment and reasoning exercised by EPA engineers when designing and conducting emis-

sions tests has been validated[6] by ANAB[5], a body designed to accredit labs.

5.2.1.3.2 Alignment with Requirements

VW's cars would be considered in alignment with requirements by the EPA due to the defeat device used[27]. In reality, VW's cars were not in alignment with the requirements, as they would not have passed the EPA's tests without cheating[24].

5.2.1.3.3 Trials to Measure Quality

The EPA's engineers had designed tests to measure the levels of several types of emissions, including Nitrogen Oxide[1]. These tests are meant to simulate real-world driving conditions in a number of common scenarios. However, the EPA's engineers were required to make the testing information public before actually conducting the tests[27].

5.2.1.3.4 Health-Related Aspects of Human Needs

The West Virginia University study shows that VW's automobiles were emitting Nitrogen Oxide at levels of almost 40 times those allowed by the EPA[27]. Nitrogen Oxide poses a serious risk to human health, and mainly affects the respiratory system[7]. It is clear that the EPA's engineers allowed the production of software that diminished the health-related aspects of human needs.

5.2.1.3.5 Emissions Conform to Standards

Although VW's cars appeared to conform to standards[27], they did not[24]. Therefore, the EPA's engineers ultimately failed to ensure that VW's cars produced emissions that conformed to the governing standards for emissions.

5.2.1.4 Conclusion

Although the EPA's engineers (1) failed to ensure that VW's cars produced emissions that con-

formed to the governing standards for emissions and (2) allowed the production of software that diminished the health-related aspects of human needs, there are multiple qualifiers that complicate the determination of whether the EPA's engineers violated the Software Engineering Code.

The EPA's engineers chose to approve the emissions levels of VW's automobiles based on excellent judgment and reasoning. The EPA emissions testing laboratory has been accredited[6] by ANAB[5], and is therefore considered to be capable of adequately designing and implementing labs.

The EPA's engineers verified that VW's cars did conform to emissions standards in their tests[24]. However, these results were false due to deception on the part of VW[11].

The EPA's engineers verified VW's cars' emissions via a standard test[20]. While the test failed to correctly assess the real-world emissions of VW's vehicles, the fault is not entirely on the EPA's engineers. VW was able to exploit the testing process by gaining an understanding of the test track, which the EPA is required to publish[1]. Therefore, VW was able to cheat the EPA emissions test due to a systemic oversight on the part of the EPA, rather than a flawed design or implementation on the part of the engineer.

Because the EPA's engineers made their assessment based on excellent judgment and reasoning, verified that VW's cars passed their test, and were not at fault for VW's exploitation of the test, they meet the qualifiers showing that they were not in violation of the Software Engineering Code of Ethics.

5.3 Tenet 1.05

5.3.1 Tenet

> Cooperate in efforts to address matters of grave public concern caused by software, its installation, maintenance, support or documentation.

5.3.1.1 Definitions

5.3.1.1.1 Cooperate

To cooperate is defined as "to work together or act jointly for a common purpose or benefit"[2].

5.3.1.1.1.1 Common

Common is defined as "belonging equally to, or shared alike by, two or more or all in question"[2].

5.3.1.1.1.2 Benefit

Benefit is defined as "something that is advantageous or good; an advantage"[2].

5.3.1.1.1.3 Reconstruction

Using the above definitions, to cooperate means "to work together for something advantageous that is shared equally by all".

5.3.1.1.2 Efforts

Efforts are defined as "earnest or strenuous attempts"[2].

5.3.1.1.2.1 Earnest

Earnest is defined as "serious in intention, purpose, or effort; sincerely zealous"[2].

5.3.1.1.2.1.1 Serious

Serious is defined as "requiring thought, concentration, or application"[2].

5.3.1.1.2.2 Reconstruction

Using the above definitions, Effors are defined as "attempts requiring thought".

5.3.1.1.3 Address

To address is defined as "to direct to the attention"[2].

5.3.1.1.4 Grave

Grave is defined as "threatening a seriously bad outcome or involving serious issues"[2].

5.3.1.1.4.1 Serious

See 5.3.1.1.2.1.1.

5.3.1.1.4.2 Reconstruction

Using the above definitions, grave means "threatening an outcome which requires thought, concentration, or application".

5.3.1.1.5 Public

Public is defined as "of, relating to, or affecting a population as a whole"[2].

5.3.1.1.6 Concern

Concern is defined as "a matter that engages a person's attention, interest, or care, or that affects a person's welfare or happiness"[2]

5.3.1.1.6.1 Welfare

Welfare is defined as "the good fortune, health, happiness, prosperity, etc., of a person, group, or organization; well-being"[2].

5.3.1.1.6.2 Reconstruction

Using the above definitions, concern is defined as "a matter that affects a person's good health".

5.3.1.1.7 Software

The definition for software will be the same as the one provided above[3], and is defined as "the software on VW's cars".

5.3.1.1.8 Installation

Installation is defined as "the act of placing in position or connect for service or use"[2].

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[3]5.1.1.8.1

5.3.1.2 Domain Specific Tenet 1.05

> The EPA's engineers should work together in attempts requiring thought to direct to the attention matters that threaten a population's good health or environment in such a way as to require thought, concentration, or application caused by the software on VW's cars or its connection for service or use.

5.3.1.3 Analysis

5.3.1.3.1 Attempts Requiring Thought

The EPA's engineers are accredited[6] by ANAB[5] to design and implement proper lab tests. Therefore, the thought required to produce tests which merit accreditation can be considered serious.

5.3.1.3.2 Direct to the Attention

The EPA releases yearly reports on the emissions data they collect, grouped by car manufacturer[8]. This report directs the attention of the public to the emissions of various car companies, and provides consumers with access to information that aids in educated consumption of goods from the automotive industry.

5.3.1.3.3 Matters that Threaten a Population's Good Health Caused by the Software on VW's Cars

The report[8] released by the EPA specifically separates VW from the rest of the data, stating that it is because the company is under investigation, and that readers should be wary of the data provided for VW. The report additionally states that before using the data given for VW, readers should attempt to find more up-to-date information, as results yielding from ongoing investigations will only be reflected in future reports.

5.3.1.4 Conclusion

The EPA's engineers have been proven to have worked together in serious attempts, as shown by their ANAB accreditation[6]. They have taken efforts to direct the attention of the public through their annual reports on vehicles' greenhouse gas emissions[8]. They have created distinctions between data compliant with the EPA's emissions guidelines and VW's data, which may not be reliable. Through their actions, the EPA's engineers have taken direct steps to ensure compliance with Tenet 1.05 of the Software Engineering Code of Ethics.

5.4 Tenet 3.01

5.4.1 Tenet

> Strive for high quality, acceptable cost and a reasonable schedule, ensuring significant trade-offs are clear to and accepted by the employer and the client, and are available for consideration by the user and the public.

5.4.1.1 Definitions

5.4.1.1.1 Strive

To strive is defined as "to exert oneself vigorously; try hard"[2].

5.4.1.1.2 High, Acceptable, Reasonable

High is defined as "exceeding the common degree or measure; strong; intense". Acceptable is defined as "pleasing to the receiver; satisfactory; agreeable; welcome"[2]. Reasonable is defined as "agreeable to reason or sound judgment; logical"[2].

5.4.1.1.3 Trade-offs

A trade-off is defined as "the exchange of one thing for another of more or less equal value, especially to effect a compromise"[2].

5.4.1.1.4 Clear

Clear is defined as "free from ... obscurity,..."[2].

5.4.1.1.5 Accepted

Accepted is defined as "generally approved, usually regarded as ... right,..."[2].

5.4.1.1.6 Available for Consideration

Available is defined as "readily obtainable; accessible"[2]. Consideration is defined as "...; careful thought; ... deliberation"[2].

Available for consideration can therefore be defined as "readily obtainable for deliberation".

5.4.1.2 Domain Specific Tenet 3.01

> EPA engineers should exert themselves vigorously to attain quality exceeding the common degree or measure, agreeable cost, and a logical schedule, ensuring significant exchanges of one thing for another of more or less equal value are not obscured from and are generally approved by the employer and the client, and are readily obtainable for deliberation by the user and the public.

5.4.1.3 Analysis

5.4.1.3.1 Level of Exertion

The EPA demonstrates high quality test results through their ANAB accreditation[6], which states that they are able to adequately design and implement lab tests. Furthermore, the EPA's mission is to "protect human health and the environment", and that they accomplish this by producing regulations to enforce environmental laws produced by Congress[9]. As the standard body for enforcement of environmental regulation, the EPA is a representation of the wants of its clients, and therefore produces results of high quality that are acceptably priced and reasonably scheduled.

5.4.1.3.2 Exchanges of One Thing for Another

The EPA's engineers' emissions tests must produce results[8] which state whether a vehicle is in compliance with emissions regulations. The acceptable levels of emissions are released by the EPA[19], and act as lines that optimize both environmental impact and vehicular utility.

5.4.1.3.3 Obscurity of Exchanges/Readily Obtainable for Deliberation

In order to ensure that all trade-offs between the EPA and its clients (the American people) regarding emissions testing are made clear, the EPA makes public all information pertaining to the acceptable standards for emissions[19].

5.4.1.4 Conclusion

Because the EPA's engineers released their test track information to the public[19], VW was able to know beforehand how their cars would be tested[15], and design their defeat devices accordingly. Had the EPA's engineers not released the test track information, VW would have been unable to prepare a device that was able to cheat the emissions test in the way that it did.

However, had the EPA's engineers *not* released the test track information[19], they would have increased the obscurity of any trade-offs they were required to make in their test design process, and their clients would not have been able to retrieve these trade-offs for deliberation.

Although VW was able to take advantage of the EPA's transparency[15], it is not the fault of the EPA's engineers, who were taking actions that placed them in accordance with this tenet of the SE Code[19]. The EPA's engineers were required to remain open with their clients, the American people, in order to remain in accordance with this tenet of the SE code.

5.5 Conclusion

The EPA's engineers acted as software engineers by conducting tests on portions of VW cars controlled by the cars' software[16, 20]. The EPA's engineers are therefore subject to the SE Code. Through an analysis of SE Code Tenets 1.03, 1.05, and 3.01, the EPA's engineers have been shown to be in compliance with the SE Code.

Analysis of Tenet 1.03 shows that although the EPA's engineers failed to detect VW's defeat device[24] and ultimately allowed for excessive emissions of Nitrogen Oxide[19], their reasoning was based in excellent judgment and reasoning[6]. Additionally, the EPA's engineers were shown to be not at fault for the flaws in test design that allowed VW to cheat, as the engineers were required to implement components of the test a certain way to maintain transparency to the public[19].

Analysis of Tenet 1.05 further backs up the EPA's engineers' decision to allow the publishing of their test track. The EPA's engineers fulfill both the component of the tenet pertaining to their ability to seriously test VW's software[6] as well as the component supporting the importance of drawing the attention of the American people to any wrongdoing discovered when testing[8].

Analysis of Tenet 3.01 also deals with the EPA's maintenance of transparency with the American people. The analysis of this tenet solidifies the idea that maintenance of transparency is essential to remaining compliant with the SE Code[1].

The analysis of these tenets demonstrates that the EPA's engineers were not in violation of the software engineering code, as their actions were consistently in compliance with the tenets selected.

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