CS 4530
Fundamentals of Software Engineering

Module 15: Ethics in Software Engineering

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Goal: to make software an engineering discipline

Software engineering concerns the

- design
- construction,
- and maintenance
- ➢ of large programs
- ➢ over time.

Programs are not morally neutral things

- programs can have good and ill effects for people
- programs represent and encode human values

Software Engineers have professional obligations around ethics

Following regulations alone is not enough

Citigroup Center

- Design met building code, but did *not* account for all failure modes
- Last-minute changes to construction increased odds of failure
- Fixed before disaster could strike, but kept a secret for 20 years

https://en.wikipedia.org/wiki/Citicorp_Center_engineering_crisis

Programs can have good and ill effects

Badly-engineered software can kill people

- Therac-25 (1985-1987)
- Bug in software caused 100x greater exposure to radiation than intended
- At least 6 died
- Likely far more suffered: deaths occurred over a period of 2 years!
- Weak accountability in manufacturer's organization

"Therac-25" by Catalina Márquez, Wikimedia commons, CC BY-SA 4.0

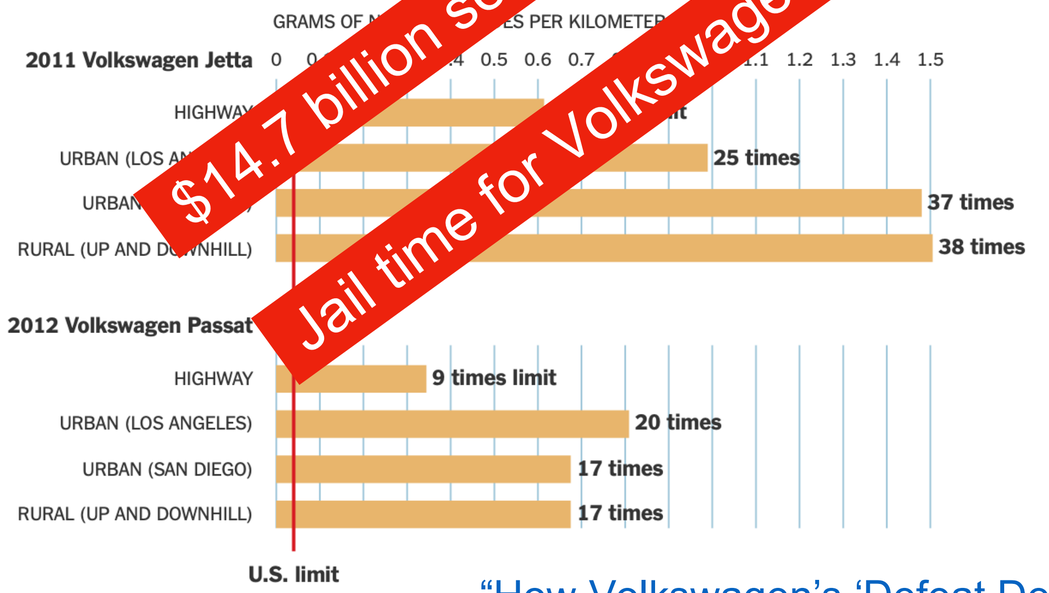
https://ethicsunwrapped.utexas.edu/case-study/therac-25

Criming Corporate Bosses Need Software Engineers

The Emissions Tests That Led to the Discovery of VW's Cheating

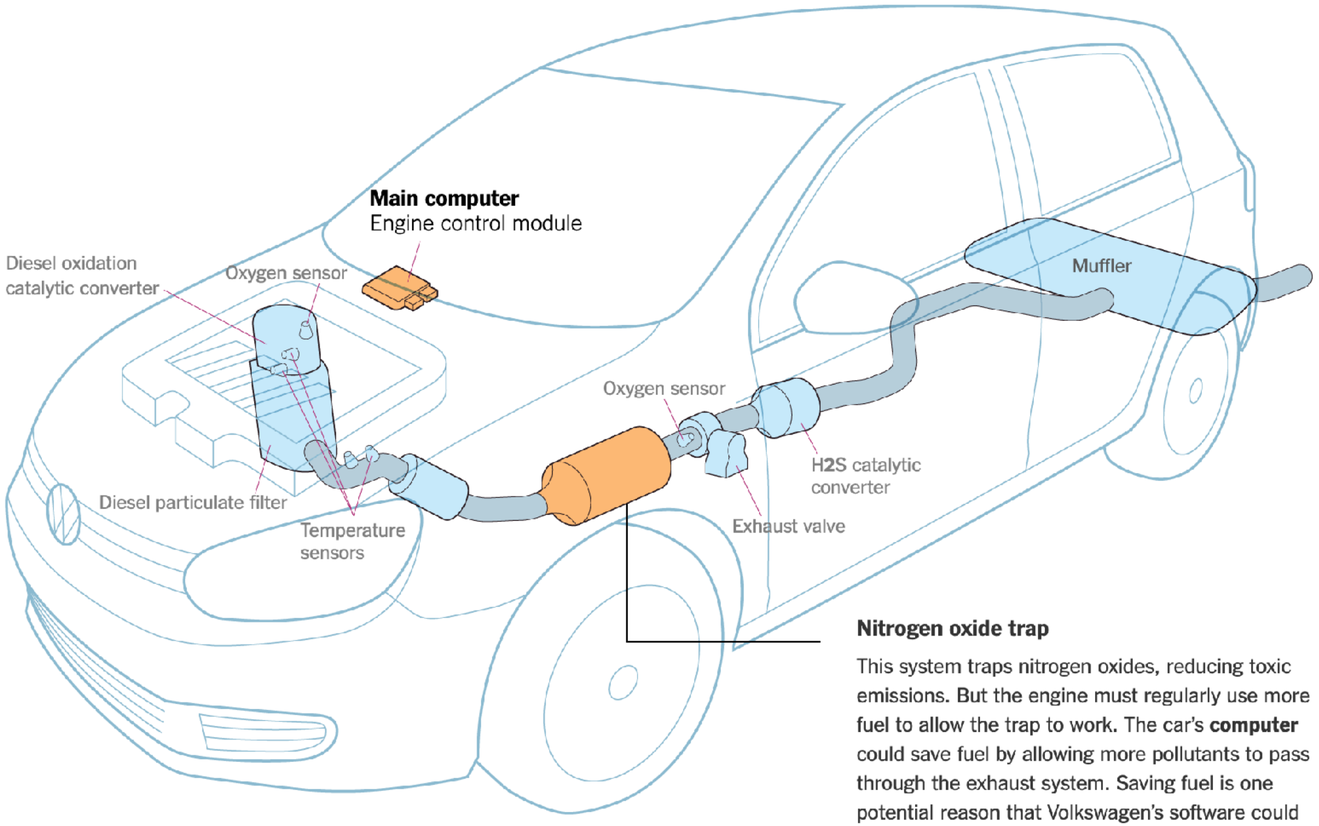
The on-road testing in May 2014 that led the California Air Resources Board to investigate Volkswagen was conducted by researchers at West Virginia University. They tested emissions from two VW models equipped with the 2-liter turbocharged 4-cylinder diesel engine. The researchers found that when tested on the road, some cars emitted almost **40 times** the permitted levels of nitrogen oxides.

Average emissions of nitrogen oxides in testing



$14.7 billion settlement

Jail time for Volkswagen Execs



Nitrogen oxide trap

This system traps nitrogen oxides, reducing toxic emissions. But the engine must regularly use more fuel to allow the trap to work. The car's **computer** could save fuel by allowing more pollutants to pass through the exhaust system. Saving fuel is one potential reason that Volkswagen's software could have been altered to make cars pollute more, according to researchers at the International Council on Clean Transportation.

Illustration by Guilbert Gates | Source: Volkswagen, The International Council on Clean Transportation

"How Volkswagen's 'Defeat Devices' Worked" By Guilbert Gates, Jack Ewing, Karl Russell and Derek Watkins

"Volkswagen executives get prison time in 'Dieselgate' scandal" By Kevin Williams, May 2025

Is This A Good Idea? It Can Depend on What Question You're Asking

There are deaths here attributed to software bugs!

List of Tesla Autopilot crashes

Article Talk

From Wikipedia, the free encyclopedia

Tesla Autopilot, a Level 2 advanced driver assistance system (ADAS), was released in October 2015 and the first fatal crashes involving the system occurred less than one year later. The fatal crashes attracted attention from news publications and United States government agencies, including the National Transportation Safety Board (NTSB) and National Highway Traffic Safety Administration (NHTSA), which has argued the Tesla Autopilot death rate is higher than the reported

Tesla will tell you that more lives were saved than if the software hadn't existed

Is This A Good Idea? What's "Good" Can Be Different For Different People or Groups

One mark of an exceptional engineer is the ability to understand how products can advantage and disadvantage different groups of human beings

Engineers are expected to have technical aptitude, but they should also have the discernment to know when to build something and when not to

Demma Rodriguez
Head of Equity Engineering
Google

Quote: "Software Engineering at Google: Lessons Learned from Programming Over Time," Wright et al, 2020 (O'Reilly)

UIs can discriminate against the differently-abled

Domino's Would Rather Go to the Supreme Court Than Make Its Website Accessible to the Blind

Rather than developing technology to support users with disabilities, the pizza chain is taking its fight to the top

by Brenna Houck | @EaterDetroit | Jul 25, 2019, 6:00pm EDT

SHARE

Pizza LLC v. Robles

"Domino's Would Rather Go to the Supreme Court Than Make Its Website Accessible to the Blind" by Brenna Houck, Eater Detroit

Jul 15 2019	**Brief amicus curiae of Washington Legal Foundation filed.**
Jul 15 2019	**Brief amici curiae of Retail Litigation Center, Inc., et al. filed.**
Jul 15 2019	**Brief amicus curiae of Cato Institute filed.**
Jul 15 2019	**Brief amicus curiae of Restaurant Law Center filed.**
Jul 15 2019	**Brief amici curiae of Chamber of Commerce of the United States of America, et al. filed.**

Is This A Good Idea? What's "Good" Can Be Different For Different People or Groups

"Earlier this week, X announced it will soon roll out a new function, allowing blocked accounts to still view public posts by users who have blocked them… One commenter wrote, "Big day for stalkers and harassers," while another stated, "That's not blocking. It's supporting stalking.""

https://tech.yahoo.com/apps/articles/bluesky-app-trends-elon-musk-172408742.html

Programs represent and encode human values

ML (also LLMs, etc.) Reinforce, “Launder” Bias

- The COMPAS sentencing tool discriminates against black defendants

	ALL	**WHITE** DEFENDANTS	**BLACK** DEFENDANTS
Labeled **High Risk**, But **Didn’t** Re-Offend	**32%**	**23%**	**44%**
Labeled **Low Risk**, Yet **Did** Re-Offend	**37%**	**47%**	**28%**

Analysis of Broward County data: “How We Analyzed the COMPAS Recidivism Algorithm” by Larson et al.

ML (also LLMs, etc.) Reinforce, "Launder" Bias

According to Wilson & Caliskan:

- human biases lead to people with names identified as "white" getting hired more
- system trained on who got hired in the past

Machine learning algorithms can be great at teasing out how we're actually making decisions (sometimes badly!)

Figure 9: Resumes with White male names are preferred in 100% of tests; those with Black male names are preferred in 0%. Gray regions indicate disparities which are not significantly different from zero (0% of tests).

Kyra Wilson & Aylin Caliskan, "Gender, Race, and Intersectional Bias in Resume Screening via Language Model Retrieval" https://ojs.aaai.org/index.php/AIES/article/view/31748

Stable Matching and the NRMP

“When residencies were first introduced, around 1900, hospitals began competing with one another to secure the best residents as early as possible. By the 1940s, positions were being offered in the third-year of medical school. Students were making career decisions without adequate exposure to their options, and hospitals were making hiring decisions with little data.”

https://pmc.ncbi.nlm.nih.gov/articles/PMC3399603/

Stable Matching and the NRMP

- 1952 National Resident Matching Program — big centralized assignment of residents to programs.
- *Stable Matching* is a property of weighted graphs: if Jimmy gets assigned to Mass General but would prefer Emory University, Emory prefers *everyone* assigned to them over Jimmy. (No defections.)
- Algorithm naturally has “proposers” and “acceptors,” and generalizing how applications generally work, natural to make potential applicants the proposers.
- Multiple stable matchings usually exist. That “natural” choice leads to the *best* outcomes for hospitals, and the *worst* outcomes for students.

Stable Matching and the NRMP

American Economic Review

ISSN 0002-8282 (Print) | ISSN 1944-7981 (Online)

The Redesign of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design

Alvin E. Roth

Elliott Peranson

AMERICAN ECONOMIC REVIEW
VOL. 89, NO. 4, SEPTEMBER 1999
(pp. 748–780)

https://www.aeaweb.org/articles?id=10.1257/aer.89.4.748

Fixes several problems

- Switches proposer/acceptor roles
- *Handles the reality of married couples that want to match in the same program or city*

Even Database Schema are Not Morally Neutral!

https://steamcommunity.com/discussions/forum/1/1496741765144289150/

Falsehoods Programmers Believe About Names

1. People have exactly one canonical full name.
2. People have exactly one full name which they go by.
3. People have, at this point in time, exactly one canonical full name.
4. People have, at this point in time, one full name which they go by.
5. People have exactly N names, for any value of N.
6. People's names fit within a certain defined amount of space.
7. People's names do not change.
8. People's names change, but only at a certain enumerated set of events.
9. People's names are written in ASCII.
10. People's names are written in any single character set.
11. People's names are all mapped in Unicode code points.
12. People's names are case sensitive.
13. People's names are case insensitive.
14. People's names sometimes have prefixes or suffixes, but you can safely ignore those.
15. People's names do not contain numbers.
16. People's names are not written in ALL CAPS.
17. People's names are not written in all lower case letters.

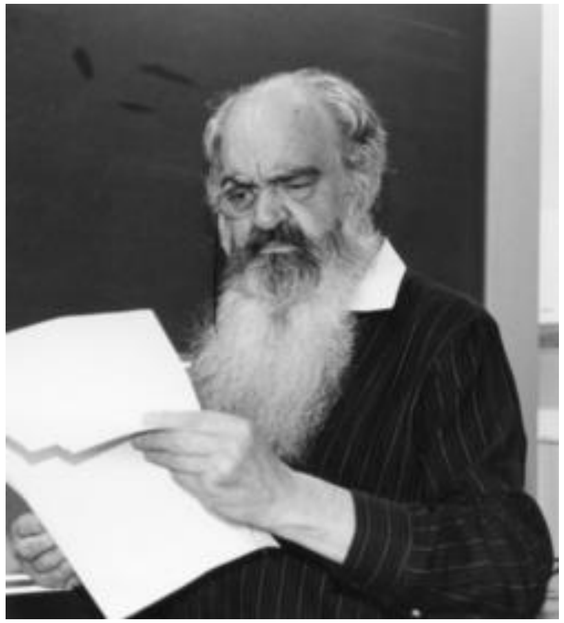
https://www.kalzumeus.com/2010/06/17/falsehoods-programmers-believe-about-names/

The Purpose of Code is What it Does

Systems: The Purpose of a System is What It Does

When trying to understand systems, one really eye-opening and fundamental insight is to realize that *the machine is never broken*. What I mean by this is, when observing the outcomes of a particular system or institution, it's very useful to start from the assumption that the outputs or impacts of that system are precisely what it was designed to do — whether we find those results to be good, bad or mixed.

https://www.anildash.com/2024/05/29/systems-the-purpose-of-a-system/



Stafford Beer, "management cybernetics"

https://en.wikipedia.org/wiki/Stafford_Beer

The Purpose of Code is What it Does

Harms associated with loot boxes, simulated gambling and other in-game purchases in video games: a review of the evidence

Nancy Greer, Cailem Murray Boyle and Rebecca Jenkinson

Australian Gambling Research Centre
Australian Institute of Family Studies

June 2022

https://www.classification.gov.au/sites/default/files/documents/agrc_literature_review_final_20220906_accessible.pdf

There are SE-level mitigations for some of these risks

- Form a diverse team: People from diverse backgrounds bring different experiences and different perspectives
- Consider human values throughout the project
- Be intentional (& flexible) about stakeholders
- Rely on standards when possible
- Monitor actual usage & misusage, user feedback
  - This is basically the philosophy of continuous delivery, but remember the McNamara fallacy (what gets measured is what gets done)

What values might our software promote or diminish?

- Human rights - Inalienable, fundamental rights to which all people are entitled
- Accessibility - Making all people successful users of the technology
- Justice - Procedural justice (process is fair) + distributive justice (outcomes are fair)
- Privacy - An individual's agency in determining what information about them is shared
- Human welfare - Physical, material and psychological well-being

Value Sensitive Design @ Khoury

"Value constraints," can be framed as negative user stories:

- "As a parent of a patient, I want my child's medical records *not* to be disclosed to unauthorized persons.

Software engineers have professional obligations around ethical behavior

https://ethics.acm.org/code-of-ethics/software-engineering-code/

ACM Software Engineering Code of Ethics

1. PUBLIC – Software engineers shall act consistently with the public interest.

2. CLIENT AND EMPLOYER – Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.

3. PRODUCT – Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.

4. JUDGMENT – Software engineers shall maintain integrity and independence in their professional judgment.

5. MANAGEMENT – Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.

6. PROFESSION – Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.

7. COLLEAGUES – Software engineers shall be fair to and supportive of their colleagues.

8. SELF – Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

Does this code change developer behavior?

Does ACM's Code of Ethics Change Ethical Decision Making in Software Development?

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ABSTRACT

Ethical decisions in software development can substantially impact end-users, organizations, and our environment, as is evidenced by recent ethics scandals in the news. Organizations, like the ACM, publish codes of ethics to guide software-related ethical decisions. In fact, the ACM has recently demonstrated renewed interest in its code of ethics and made updates for the first time since 1992. To better understand how the ACM code of ethics changes software-

The first example is the Uber versus Waymo dispute [26], in which a software engineer at Waymo took self-driving car code to his home. Shortly thereafter, the engineer left Waymo to work for a competing company with a self-driving car business, Uber. When Waymo realized that their own code had been taken by their former employee, Waymo sued Uber. Even though the code was not apparently used for Uber's competitive advantage, the two companies settled the lawsuit for $245 million dollars.

TLDR: No

Where does this leave us?

- **So that we can sleep at night**
  - Consider the different ways that our software may impact others
  - Consider the ways in which our software interacts with the political, social, and economic systems in which we and our users live
  - Follow best practices, and actively push to improve them
  - Encourage diversity in our development teams
  - Engage in honest conversations with our co-workers and supervisors to explore possible ethical issues and their implications.

Also… you just don’t always get to sleep at night.

Review

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