Principles of Software Construction: Objects, Design, and Concurrency

Toward SE in practice: Empiricism in SE

Josh Bloch **Charlie Garrod**

Administrivia

- Homework 6 available
  - Due next Wednesday, May 5th
- Final exam due Friday, May 14th, 11:59 p.m. EDT
  - Will be released Thursday, May 13th (evening EDT)
  - Exam review session Wednesday, May 12th, 7-9 p.m. EDT
  - Practice exam released late next week

Key concepts from Tuesday

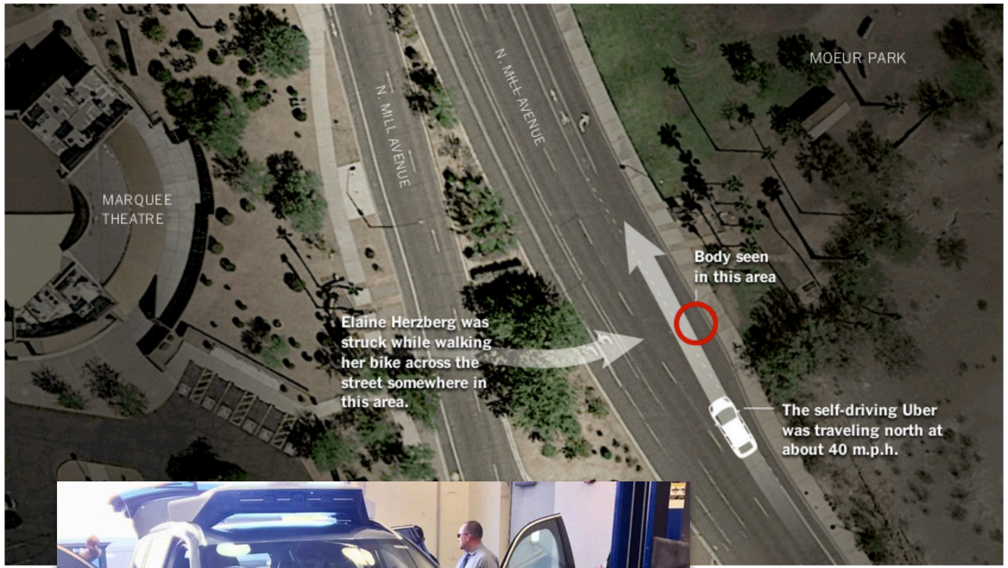
- SE as a sociotechnical system

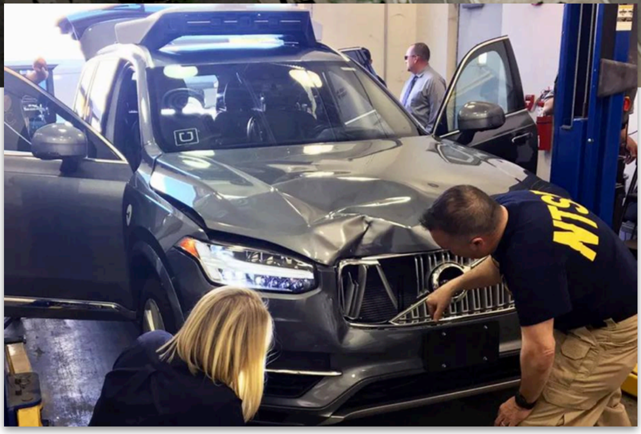
How a Self-Driving Uber Killed a Pedestrian in Arizona

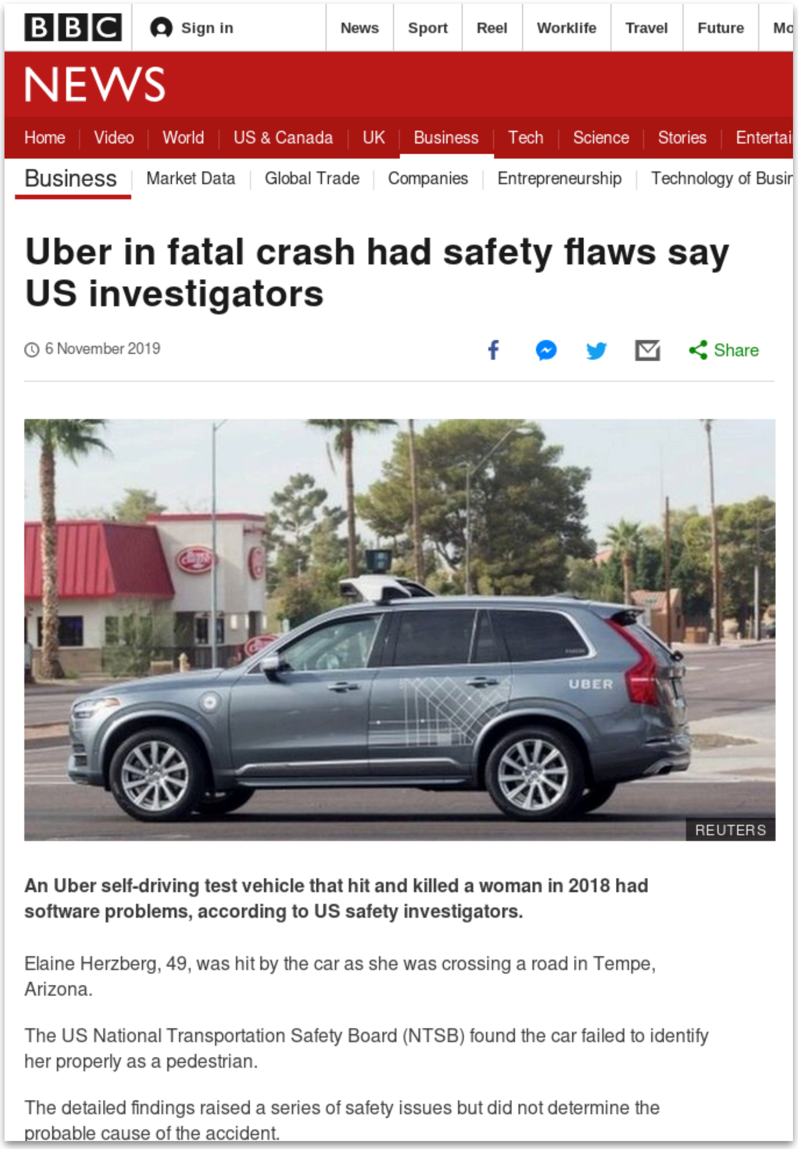
By TROY GRIGGS and DAISUKE WAKABAYASHI UPDATED MARCH 21, 2018

A woman was struck and killed on Sunday night by an autonomous car operated by Uber in Tempe, Ariz. It was believed to be the first pedestrian death associated with self-driving technology.

What We Know About the Accident


MOEUR PARK
N. MILL AVENUE
N. MILL AVENUE
MARQUEE THEATRE
Body seen in this area
Elaine Herzberg was struck while walking her bike across the street somewhere in this area.
The self-driving Uber was traveling north at about 40 m.p.h.





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Uber in fatal crash had safety flaws say US investigators

6 November 2019 Share

REUTERS

An Uber self-driving test vehicle that hit and killed a woman in 2018 had software problems, according to US safety investigators.

Elaine Herzberg, 49, was hit by the car as she was crossing a road in Tempe, Arizona.

The US National Transportation Safety Board (NTSB) found the car failed to identify her properly as a pedestrian.

The detailed findings raised a series of safety issues but did not determine the probable cause of the accident.

https://www.nytimes.com/interactive/2018/03/20/us/self-driving-uber-pedestrian-killed.html?mtrref=www.google.com&assetType=REGIWALL
https://www.bbc.com/news/business-50312340
https://www.bbc.com/news/technology-44243118

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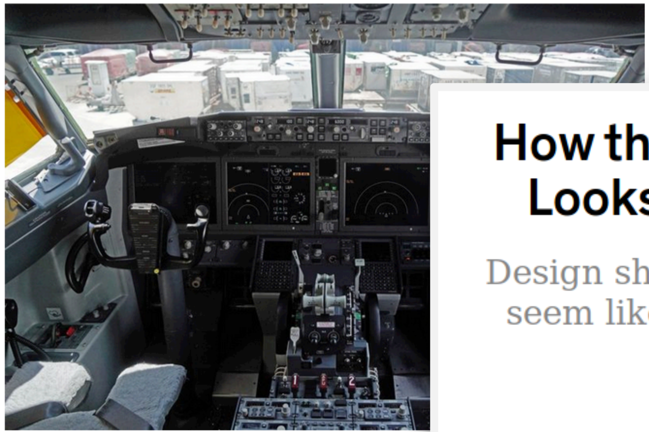
Technology

Boeing's 737 Max Software Outsourced to $9-an-Hour Engineers

By Peter Robison
June 28, 2019, 4:46 PM EDT

- Planemaker and suppliers used lower-paid temporary workers
- Engineers feared the practice meant code wasn't done right


The cockpit of a grounded 737 Max 8 aircraft. *Photographer: Dimas*

It remains the mystery at the hea
crisis: how a company renowned
made seemingly basic software m
deadly crashes. Longtime Boeing
was complicated by a push to ou
contractors.

The Max software -- plagued by is
planes grounded months longer
week revealed a new flaw -- was c
was laying off experienced engin
suppliers to cut costs.

https://spectrum.ieee.org/aerospace/aviation/h
developer

How the Boeing 737 Max Disaster Looks to a Software Developer

Design shortcuts meant to make a new plane seem like an old, familiar one are to blame

By **Gregory Travis**

The views expressed here are solely those of the author and do not represent positions of IEEE Spectrum *or the IEEE.*

Photo: Jemal Countess/Getty Images

This is part of the wreckage of Ethiopian Airlines Flight ET302, a Boeing 737 Max

A year after the first 737 Max crash, it's unclear when the plane will fly again

Two crashes of Boeing's 737 Max 8 killed 346 people, and authorities are blaming Boeing's design, a faulty sensor and airline staff. Plus: Everything you need to know about the plane.

Kent German November 1, 2019 9:01 AM PDT 63

ed killing 346 people.

ts 737 Max 8 that killed 346 people, Boeing is facing
its newest and most critical aircraft models. The
und the world, and the Federal Aviation

Major topics in 17-313 (Foundations of SE)

- Process considerations for software development
- Requirements elicitation, documentation, and evaluation
- Design for quality attributes
- Strategies for quality assurance
- Empirical methods in software engineering
- Time and team management
- Economics of software development

SE as a sociotechnical system summary

- Software engineering requires consideration of many issues, social and technical, above code-level considerations
- Interested? Take 17-313
- Shameless plug: Take API Design, 17-480

Today: Software engineering in practice

- Empiricism in SE
  - Mob programming
  - Test-driven development

Volunteer?

Mob programming

Mob programming

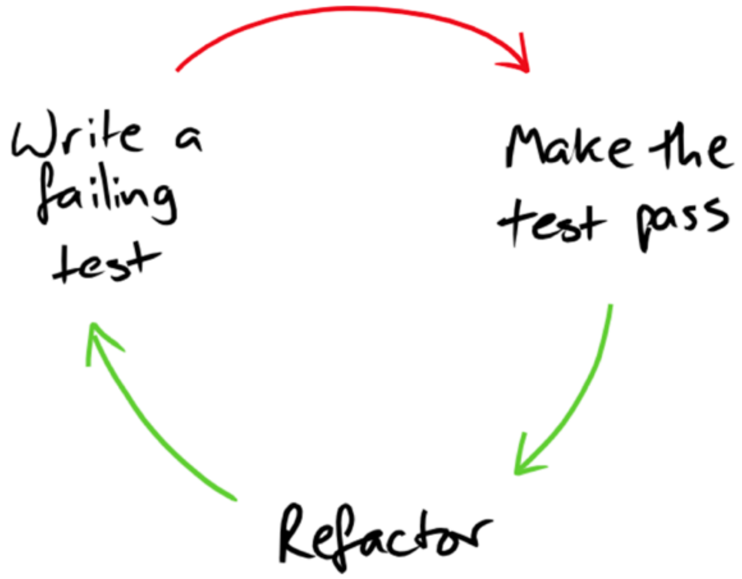
- Like pair programming, but with more people
  - Driver vs. navigators (a.k.a. the typist vs. everyone else)
  - Group decision-making
  - Frequent rotation

Today: Software engineering in practice

- Empiricism in SE
  - Mob programming
  - Test-driven development

Test-driven development (TDD)

Test-driven development (TDD), informally



From Growing Object-Oriented Software by Nat Pryce and Steve Freeman
http://www.growing-object-oriented-software.com/figures.html

@sebrose http://cucumber.io

Formal test-driven development rules

1. You may only write production code to make a failing test pass
2. You may only write a minimally failing unit test
3. You may only write minimal code to pass the failing test

Test-driven development as a design process

"The act of writing a unit test is more an act of design and documentation than of verification. It closes a remarkable number of feedback loops, the least of which pertains to verification."

Advantages of test-driven development

- Clear place to start
- Iterative, agile design process
- Less wasted effort?
- Robust test suite, including regression tests

A test-driven development demo: Diamond Kata

- Given a letter, generate a diamond starting at ‘A’, with the given letter at the widest point.
  - e.g., `diamond('C')` would generate:

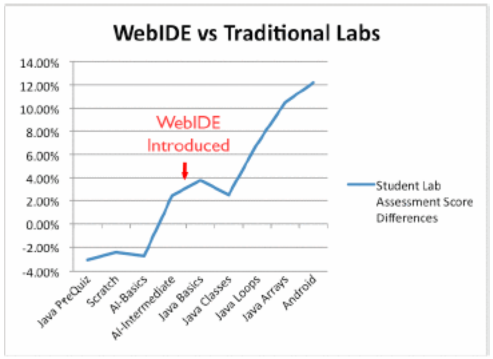
```
  A
 B B
C   C
 B B
  A
```

Formal test-driven development: Your impressions?

Empirical methods in software engineering

- How do we study the effectiveness of mob programming or test-driven development compared to other methodologies?
  - Note: Mix of social and technical issues

Research on test-driven development (1/2)



- Hilton et al.: Students learn better when forced to write tests first
- Bhat et al.: At Microsoft, projects using TDD had greater than two times code quality, but 15% more upfront setup time
- George et al.: TDD passed 18% more test cases, but took 16% more time
- Scanniello et al.: Perceptions of TDD include: novices believe TDD improves productivity at the expense of internal quality

Research on test-driven development (2/2)

- Fucci et al.: Results: The Kruskal-Wallis tests did not show any significant difference between TDD and TLD in terms of testing effort (p-value = .27), external code quality (p-value = .82), and developers' productivity (p-value = .83).

- Fucci et al.: Conclusion: The claimed benefits of TDD may not be due to its distinctive test-first dynamic, but rather due to the fact that TDD-like processes encourage fine-grained, steady steps that improve focus and flow.

Summary

- Software engineering as an empirical field
  - Quantitative and qualitative methodologies