# Managing Risks in Software Design

Embedded EthiCS, Spring 2023

# About Me

## I am Michael Pope

### Embedded EthiCS @ Harvard

# Embedded EthiCS

**Identify** ethical and social issues

**Reason** through ethical and social issues

**Communicate** reasoned positions

**Design** responsible systems

# Agenda


1. **Trade-offs and Risks in System Design**
2. **Managing *ex ante* Risks**
3. **Engagement with Stakeholders**
4. **Applications and Balancing Goals**

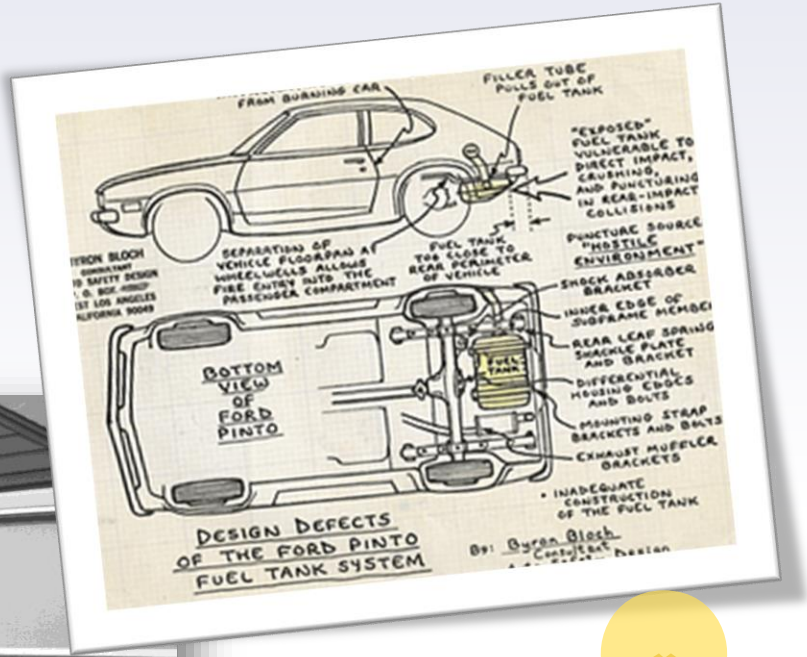
# 1 Understanding Risk

# Ford's Pinto

- **Ford's first subcompact car**
- **Available from 1971-1980 in North America**
- **Ford produced over 3.1 million  units**

# Ford's Pinto


KEEP OFF MY REAR
I'M EXPLOSIVE!


FROM BURNING CAR
FILLER TUBE PULLS OUT OF FUEL TANK
"EXPOSED" FUEL TANK VULNERABLE TO DIRECT IMPACT, CRUSHING, AND PUNCTURING IN REAR-IMPACT COLLISIONS
SEPARATION OF VEHICLE FLOORPAN AT WHEELWELLS ALLOWS FIRE ENTRY INTO THE PASSENGER COMPARTMENT
FUEL TANK TOO CLOSE TO REAR PERIMETER OF VEHICLE
PUNCTURE SOURCE "HOSTILE ENVIRONMENT"
SHOCK ABSORBER BRACKET
INNER EDGE OF SUBFRAME MEMBER
REAR LEAF SPRING SHACKLE PLATE AND BRACKET
DIFFERENTIAL HOUSING CROSS AND BOLTS
MOUNTING STRAP BRACKETS AND BOLTS
EXHAUST MUFFLER BRACKETS
BOTTOM VIEW OF FORD PINTO
FUEL TANK
• INADEQUATE CONSTRUCTION OF THE FUEL TANK
DESIGN DEFECTS OF THE FORD PINTO FUEL TANK SYSTEM
By: Byron Bloch

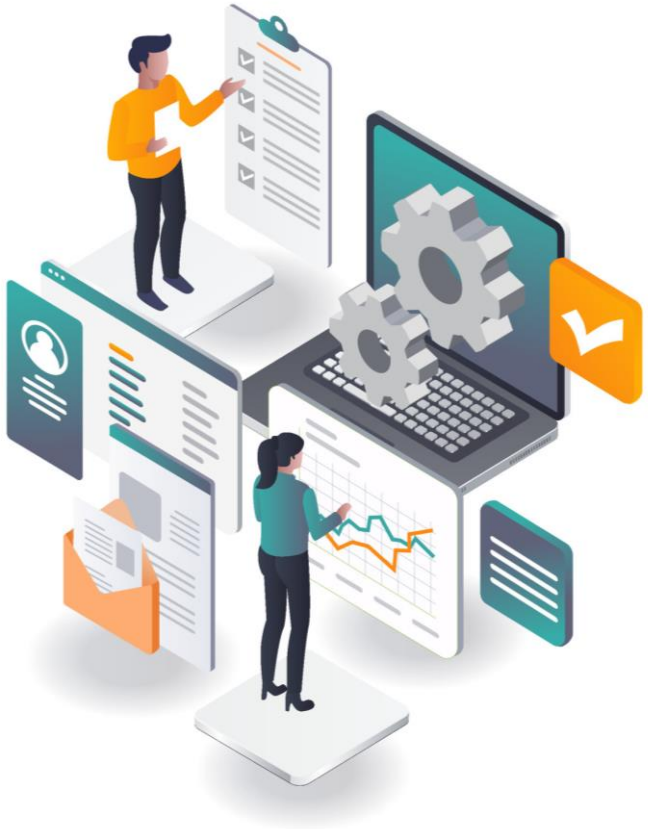
# Therac-25

- Computer controlled two modes:
  - High-current indirect
  - Low-current direct
- Malfunction problem:
  - Code error
  - Opaque interface
  - Removal of safety measures

# Risks Before and After Harms

- *Ex post:* **Recognition of risks after harm occurs**

- *Ex Ante:* **Recognition of risks before harm occurs**



# Competing Aims

**“In our private lives, most low-probability risks we run will never ripen into harm . . . Not so in the public policy realm, where the rules we choose often govern millions or hundreds of millions of events over the long term . . . We can often reduce those risks by greater precautions. But at a certain point such precautions become prohibitively costly . . .”**

**– Barbara Fried**

# Predicting Risk

**In an uncertain world, what factors should influence *ex ante* risk assessments?**

Think

Pair

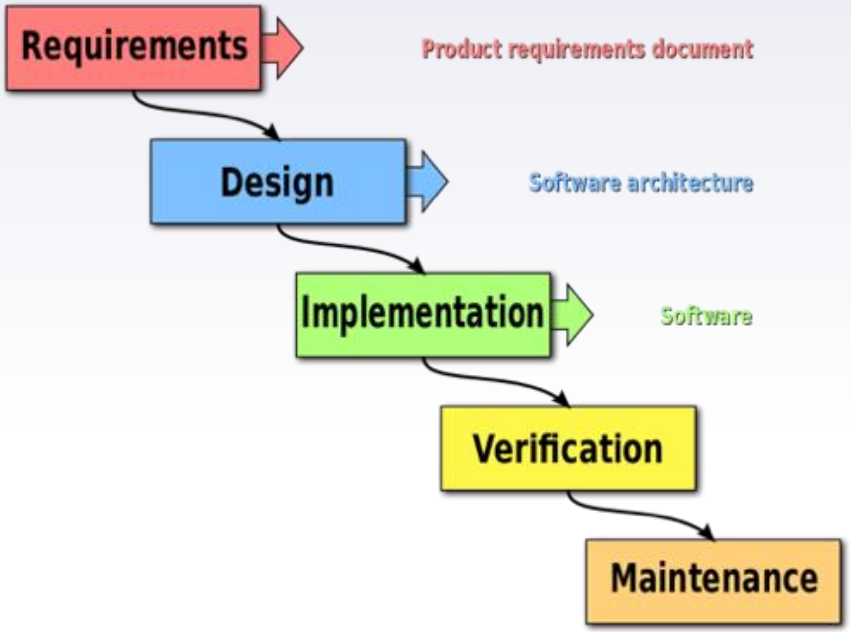
Share

# 2 Managing Risk

## Rights-based Approach


## Expected Utility Maximization

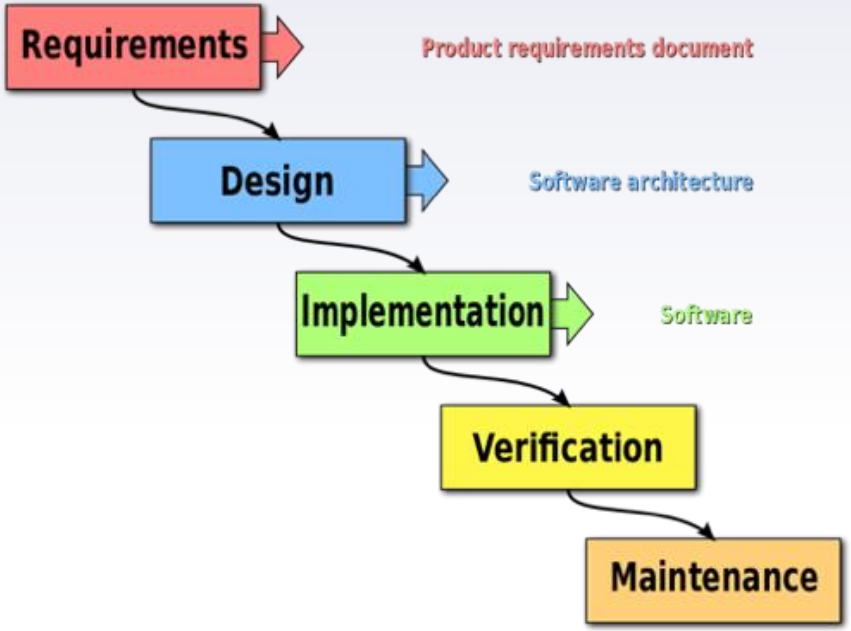

# Two Possible Approaches




## Goal Setting: Stakeholder needs and interests

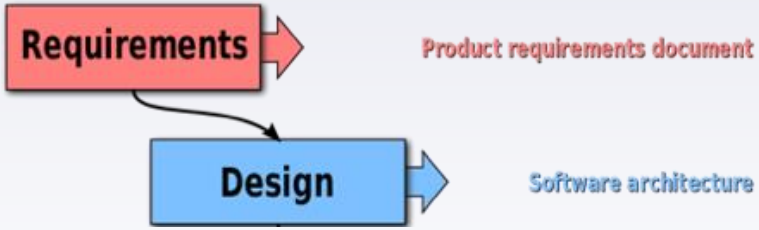
- *Customers, employees, administrators, bystanders*
- *"What product are we making?"*
- *"What features should that product have? "*

# Improving Software Design




- **Goal Setting: Stakeholder needs and interests**
- **Testing: How should we balance risks?**
  - *Validation: "Does the product meet requirements?"*
  - *Verification: "Does the product meet the requirements correctly?"*

# Improving Software Design



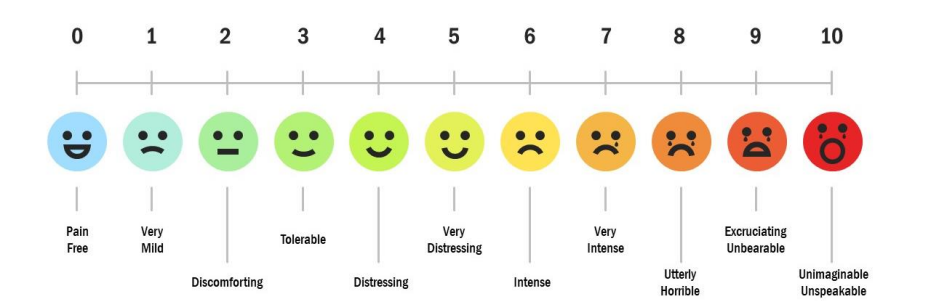

Why include stakeholder interests and needs in design?

## Inductive Risk: What if we're wrong?

1. Software developers must decide whether a piece of software is ready for deployment.
2. Deployed systems can positively or negatively impact stakeholders' values, needs, and interests.
3. Decisions about whether software is ready for deployment depend in part on judgments about the risks of error.
4. Therefore, stakeholder values should influence whether a piece of software is judged ready for deployment.

# Improving Software Design

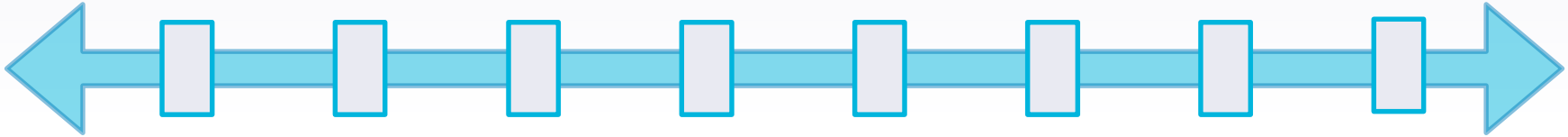
Striking a balance between risk aversion and risk tolerance can fall short of consensus.





# Balancing Constraints

Prudent Vigilance



Precautionary Principle

Proactionary Principle

# Testing: Stewardship Model

(1) Be explicit about goals and justifications

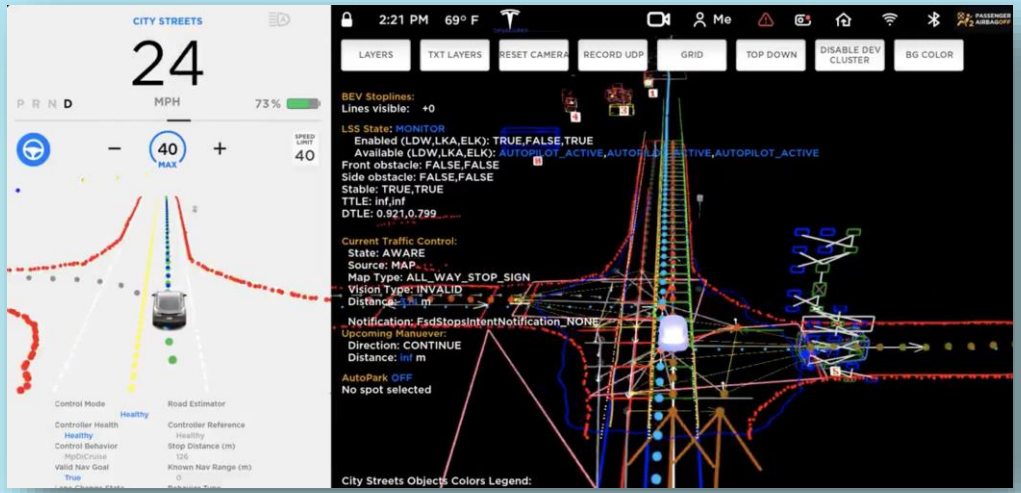
(2) Maintain independent oversight

(3) Publicly report results (including unintended consequences)

(4) Include mechanisms for “democratic oversight” in collaboration with stakeholders

# Prudential Vigilance

# When is it safe enough?




- *Full Self-driving 2023 Voluntary Recall*
- *Coding errors, resulting in: erratic braking and lane changes, rolling stops, etc.*

TESLA

# When are formal methods required?

1. **Tax filing software that calculates how much you should pay on your taxes.**
2. **Presentation app (e.g., Powerpoint or Keynote).**
3. **Game app where children ages 3+ can design the make-up and dresses of their favorite princesses.**
4. **Online data profile platform (e.g., OKCupid), which houses sensitive information, such as users' sexual orientation and history of (in)fidelity.**
5. **Mobile payment service (e.g. ApplePay, Venmo).**
6. **Home security alarm system.**
7. **Wearable tech (e.g. a FitBit or AppleWatch), which tracks and logs a users' heart rate.**

**Why** *are formal methods required?*

# THANKS!

**Exit Survey** →