



CHAPTER NO.05

COMMITMENT TO SAFETY

Engineer's Concern for Safety

- We demand safe products
...but we have to pay for safety (important for the public to know this)
- What may be safe enough for you, may not be for others
- Absolute safety is neither attainable nor affordable
- Example: 2005 earthquake...
- What exactly do we mean by “safety”?
- How do we assess it?

Safety...

- Safety, definitions:

- “A thing is safe if, were its risks fully known, those risks would be judged acceptable by a reasonable person in light of their settled value principles”

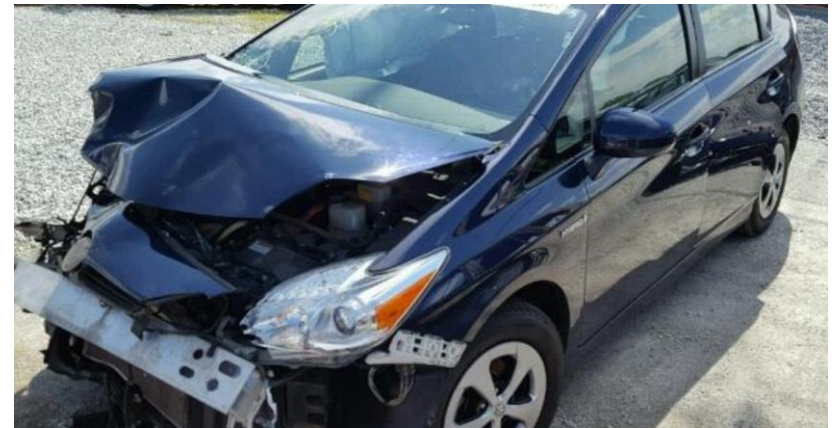
Safety is relative!

- “A thing is safe (to a certain degree) with respect to a given person or group at a given time if, were they fully aware of its risks they would judge those risks to be acceptable (to a certain degree).”

What is “degree”?

Risk

- **Definition:** A risk is the potential that something unwanted and harmful may occur
- “Experimental” risks associated with introducing new technology (“social experimentation”)



Example: Toyota Prius

ABS rear-end collisions

BECAUSE OF BRAKE FAILURE

Acceptability of Risk

- Willingness to be subjected to risk:
 - People don't have as much of a problem with subjecting themselves to risks
 - Much less willing to involuntarily be subjected to risks
- Are risks on-the-job voluntary?
What about in a manufacturing job?
 - Could quit! But is this always possible?
- Safety complaints from on-the-job should always be listened to.

Magnitude and Proximity of Risk

- What if personal connections with victims?
 - What if the person on the unsafe manufacturing line is your FAMILY?
 - A useful mental exercise to ensure that you are diligent (ATTENTIVE)!
- What creates such changed perceptions?
 - Personal/family relationships, sense of “solidarity” with workers

Proximity/magnitude - direct impact on you!

- What about work on a design project?
 - If risk appears small but there are hints that it may grow with time, BE CAREFUL!!

Lessons for the Engineer

- Engineers face two problems with public conception of safety.
 - Over-optimistic with regard to familiar products that have not hurt them before and that they have control over
 - Over-pessimism when accidents kill or harm those we know (e.g., aircraft crashes) even though statistically speaking, such accidents might occur infrequently.

Discussion Question!

Describe a real or imagined traffic problem in your neighborhood involving children and elderly people who find it difficult to cross a busy street. Put yourself in the position of

- (a) a commuter traveling to work on that street;
- (b) the parent of a child, or the relative of an older person who has to cross that street on occasion;
- (c) a police officer assigned to keep the traffic moving on that street; and
- (d) the town's traffic engineer working under a tight budget.

Describe how in these various roles you might react to

1. complaints about conditions dangerous to pedestrians at that crossing and
2. requests for a pedestrian crossing protected by traffic or warning lights.

Design Considerations, Risk

- Principles:
 - Absolute safety is not attainable
 - Improvements in safety often cost \$\$
 - Products that are not safe experience secondary costs:
 - Loss of customer goodwill and/or customers
 - Warranty expenses
 - Business failure
 - Loss of your professional employees
 - Bad climate/hiring potential

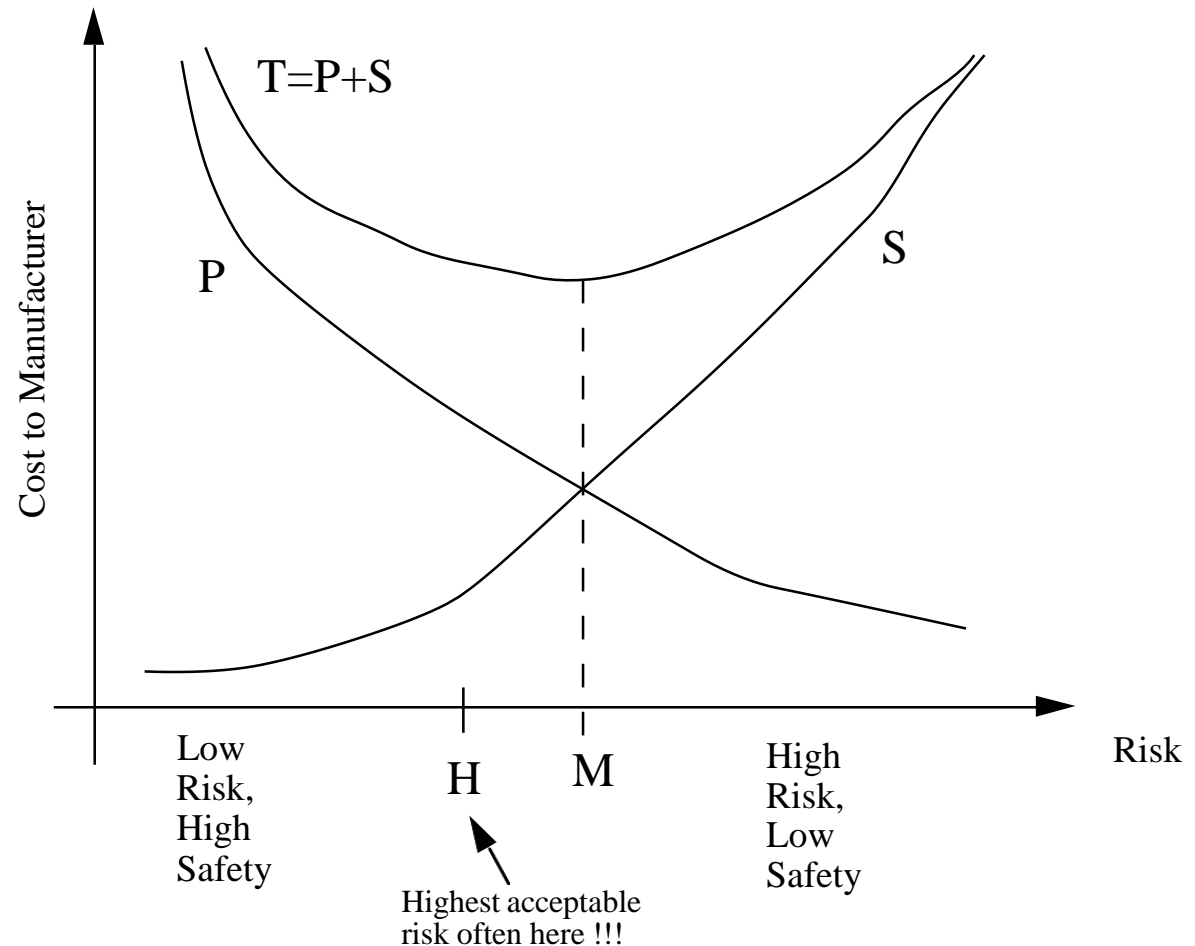
Design principle, risk/trade-offs

How safe should we make a product?

There are trade-offs...

P = primary cost of a product (including safety measures)

S = secondary costs



Knowledge of Risk

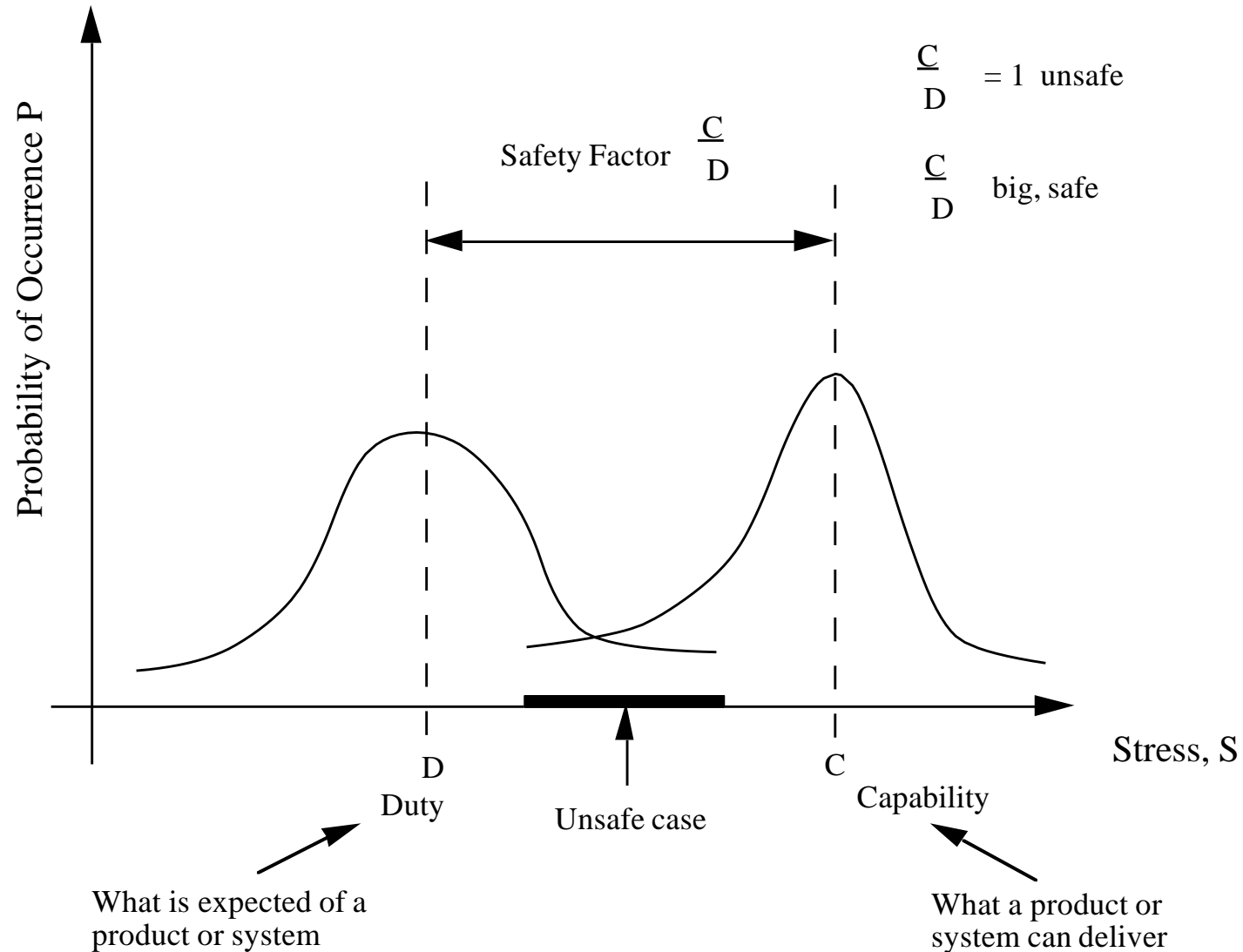
- Safety issues, even for standard products, are often not well understood
 - Information is often not shared between industries, or even engineers in an organization
 - Always new application of old technology so we do not know what our products will encounter.
- Uncertainties in design cause risk
- Engineers use “safety factors” in design

Uncertainties in design...

- Examples:
 - Designs that do well under static loads often do not do well under dynamic loads



Design Principle: Safe if Capability Exceeds Duty



Do we know capability and duty?

- No, not precisely, we must determine (estimate) it!
- Testing for safety
 - Design tests with the above comments in mind
 - Be careful to do accurate tests, be honest in trying to find the problem
 - Sometimes it may be good to get an outsider's perspective
 - Be careful with the results of other's tests - don't just blindly trust them when it comes to safety
- Testing cannot always be performed
 - Failures would be catastrophic
 - Tests are too expensive
- What do to in these cases?
 - Scenario analysis
 - Fault tree analysis

Risk-Benefit Analysis

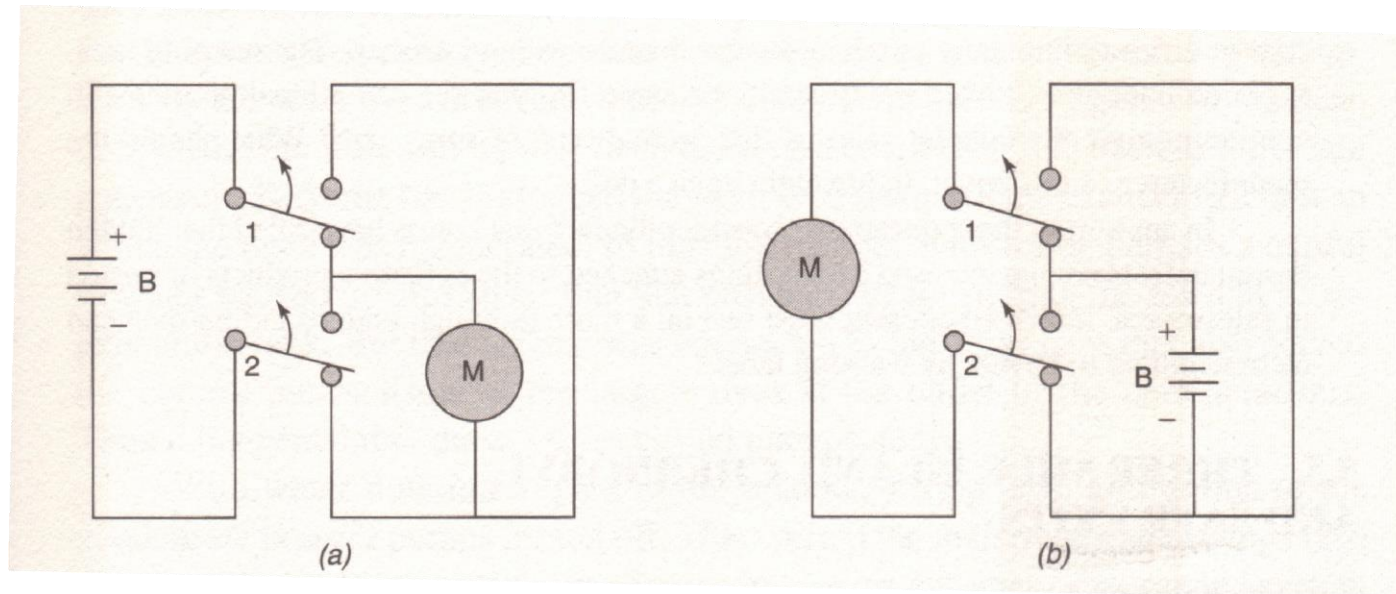
- Risk-Benefit Analysis
 - Is a product worth the risks connected with its use?
 - What are the benefits? To whom?
 - Do they outweigh the risks? To whom? Environmental impact?

“Under what conditions, if any, is someone in society entitled to impose a risk on someone else on behalf of a supposed benefit to yet others?”

- How do you place value in \$\$ on a human life?? Recall cost-benefit analysis. Human rights/dignity/respect?
- Engineers often supply facts on risk. Caution!
- **Example:** Operator error and negligence are most often not the principle causes of accidents - often unsafe conditions that are incorrectly assessed

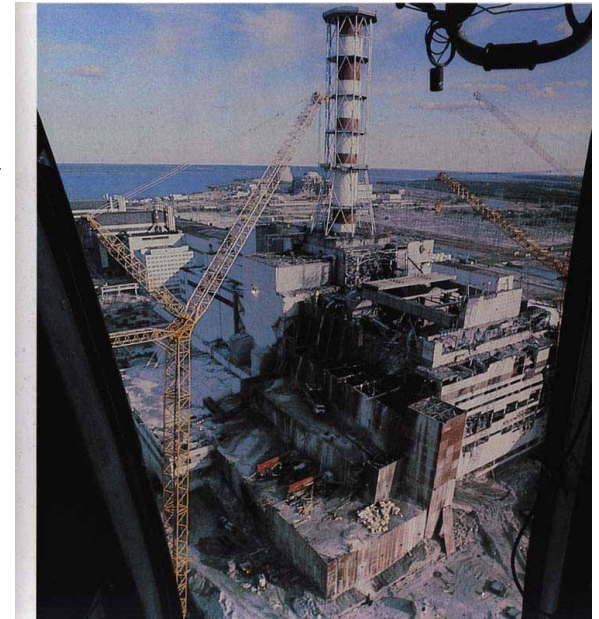
Making a product safe does not automatically increase costs

- Safety should be built into the original design
 - Warnings are often not adequate, cannot fall back on insurance!
 - Must “embed” safety; requires competence, broad perspective!
- Examples: Improved safety
 - Magnetic door catch on a refrigerator (safety for less money!)
 - Ground-fault interrupter (but costs some?)
 - Motor reverse circuit (no cost)



Fail-Safe and Safe-Exit

- Examples of “fail-safe” systems:
 - Concealed headlights on a car
 - Elevators?
- “Safe-exits” are important (fail safe, abandon/escape safe):
 - Three Mile Island, Chernobyl



Attendance Question

- **“Mock Whistle-Blowing on Safety”**: For those of you who have had a job in engineering industry:
 - Have you encountered a moral dilemma or unethical practices **with respect to safety**?
 - Please provide a brief description. *Save descriptions of unprofessional behavior for a future question...*
 - **Do not use the names of companies or people's names. I will *not* pursue cases. This is for education only!**
 - You may use a separate sheet. I reserve the right to publicly discuss or write about these.
- Please:** Put your name on the sheet of paper and turn it in...