

Engineering, Ethics and Society: Ethical Projects & Case Studies I

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Engineering 183EW, UCLA SEAS
Lecture 5

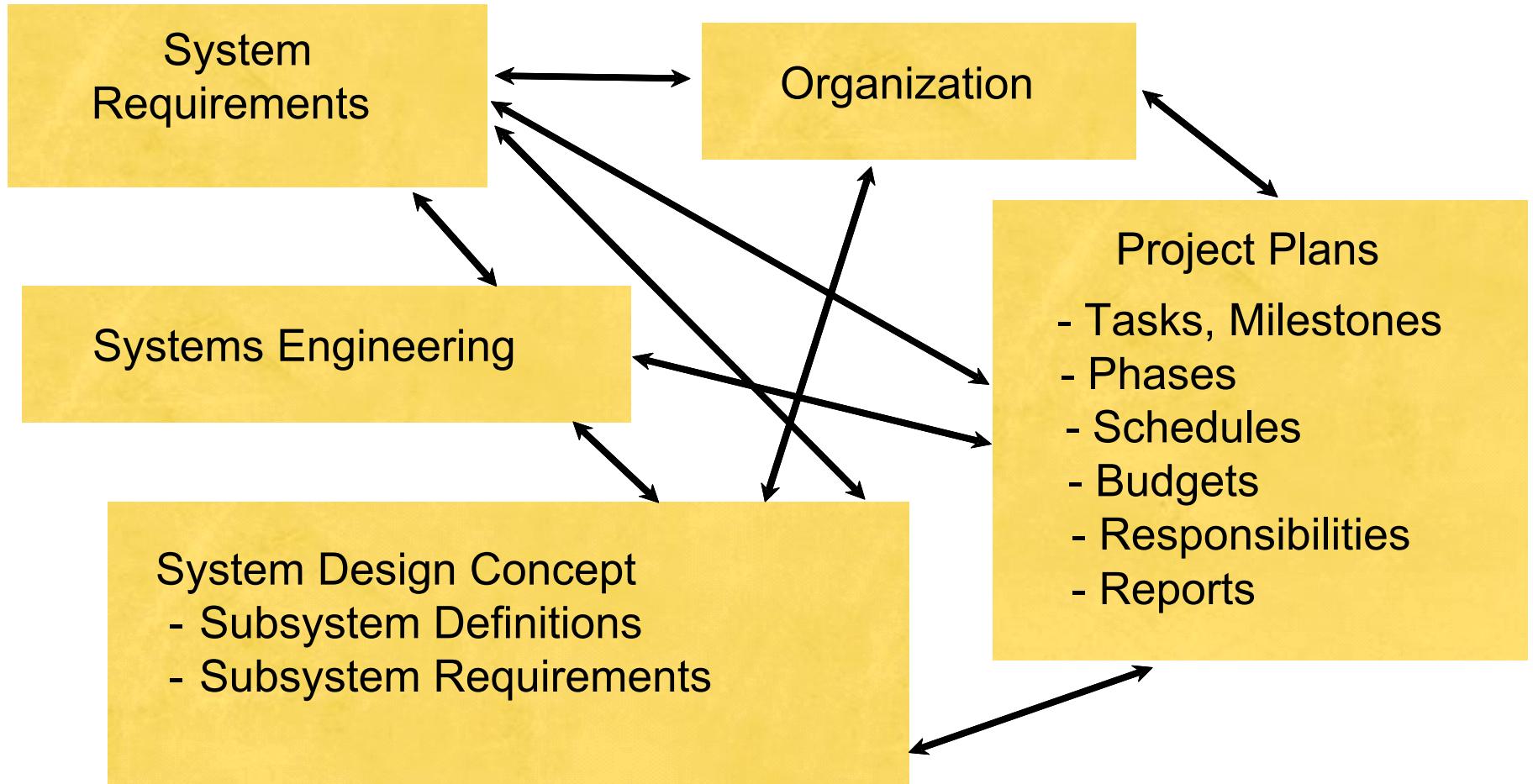
Lecture 5 Contents

- Engineering Projects
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- **The Bright Line: Ethical vs. Unethical**
- Ambiguous Ethical Cases
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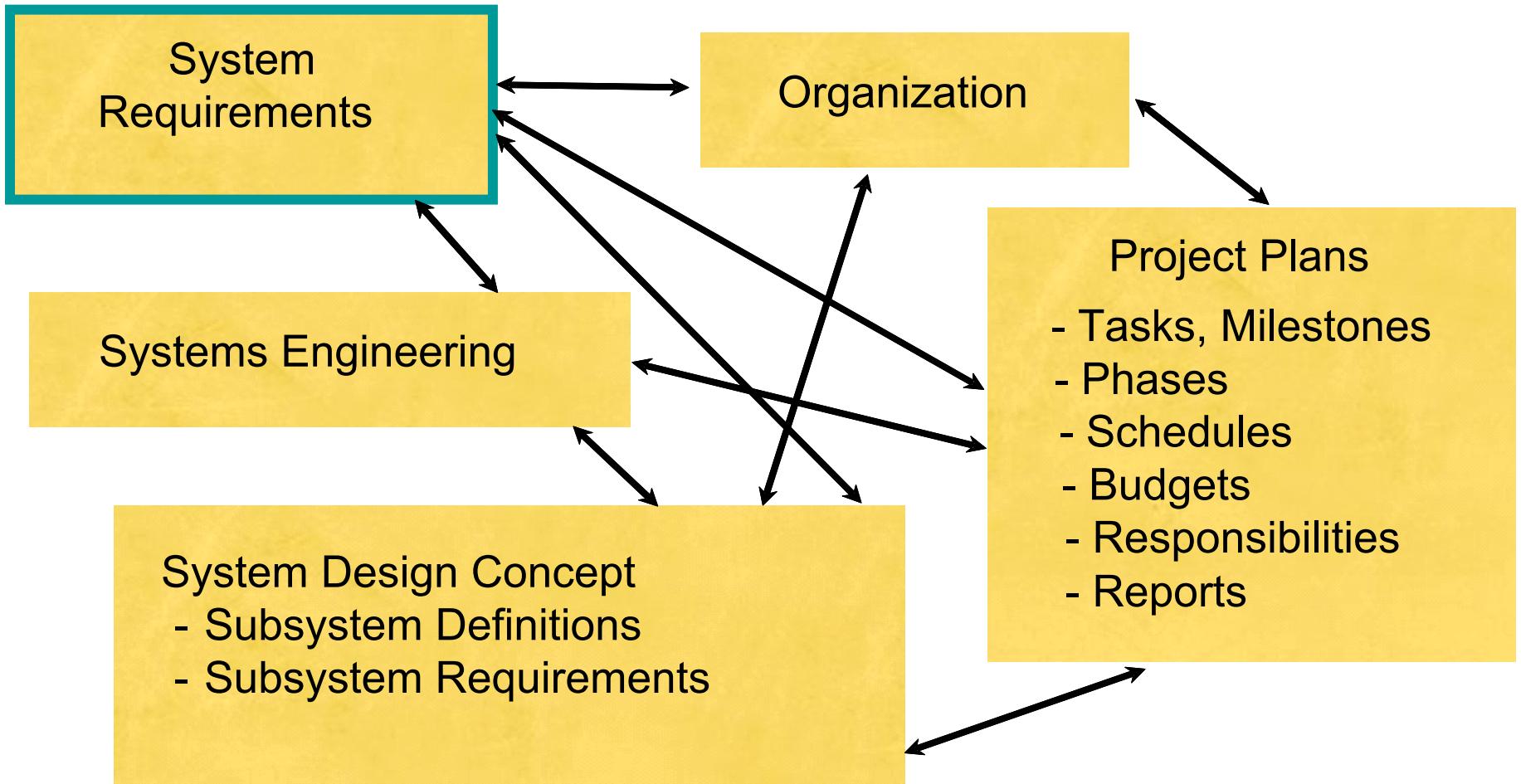
Project Definition

- Technical Activity with Specific Objectives
 - Research, Technology Development
 - Design, Prototype Demonstration
 - Production, Operation, Maintenance
- Bounded in Multiple Dimensions
 - Inputs - Requirements, Constraints
 - Outputs - Deliverable Products, Data, Reports, Services
 - Budget - Financial Resources, Funding Profile
 - Schedule - A Beginning, Task Sequence, an End
 - Resources – Personnel, Facilities, Equipment, ...
- Staffed with Dedicated Personnel
 - Scientific, Technical
 - Management
 - Administration and Support

Project Components



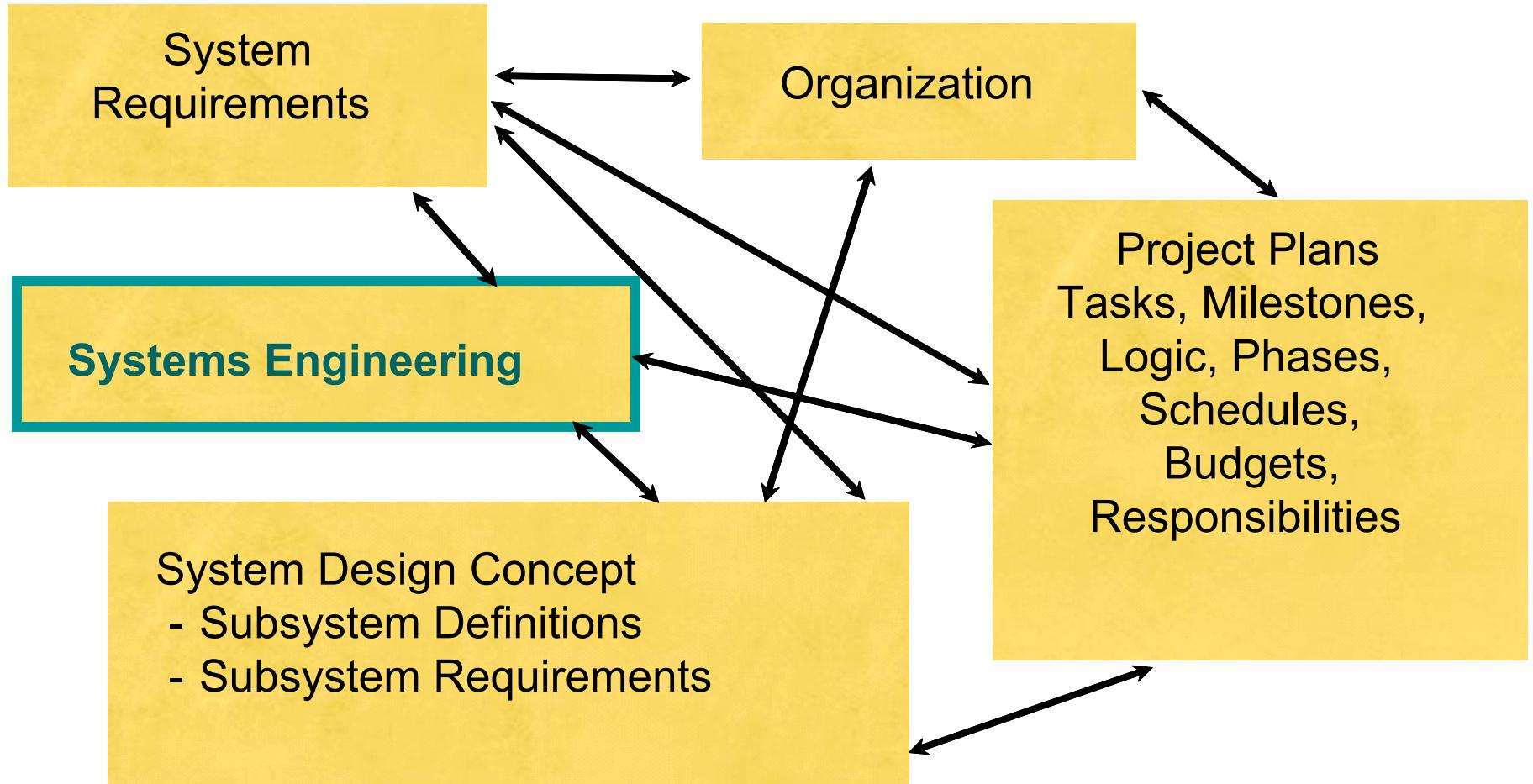
Project Components



System Requirements

<u>Sources</u>	<u>Characteristics</u>
Customers	Performance
Users	Financial
Marketplace	Schedule
Corporate	Interfaces
Personnel	Background Technology
Legal	Existing Facilities, Equipment
Nature	Laws of Physics
	Operational
	Reporting

Project Components: System Engineering



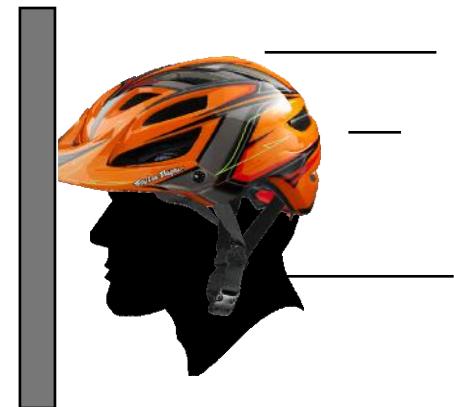
System Engineering Components

- *System Concept* defines the overall design and functions
- *Subsystems* complete the system concept
- *System Modeling* includes a schema for trading off among technical and operational parameters.
- *Modeling Data* is acquired by analysis, experimentation or prior experience
- *Verification* uses modeling data to show that requirements are achievable
- *Specifications* quantify the requirements as system design factors

While Systems Engineering is a critical engineering function, it is generally not now taught as a discipline in universities, but must be learned on the job.

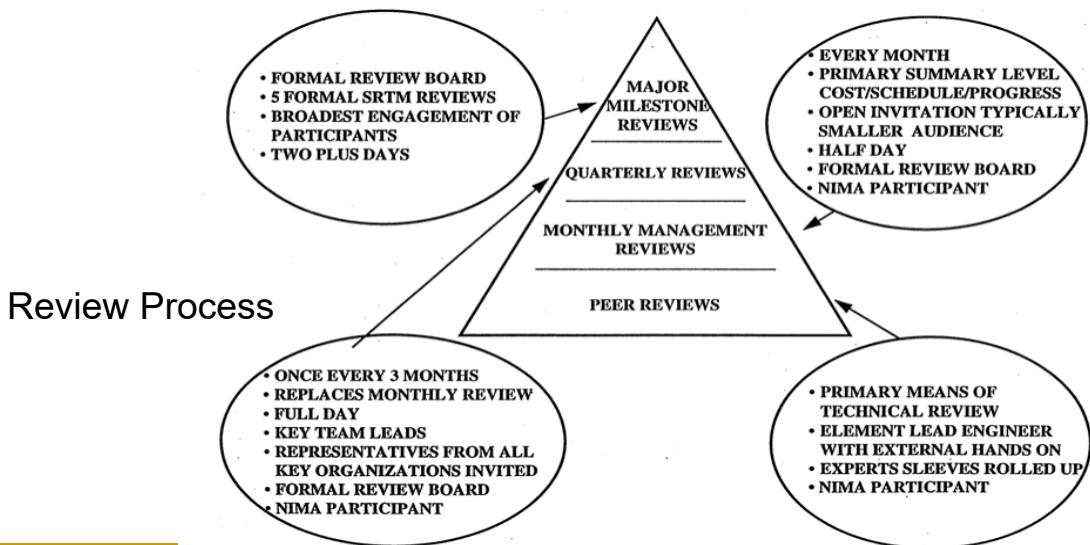
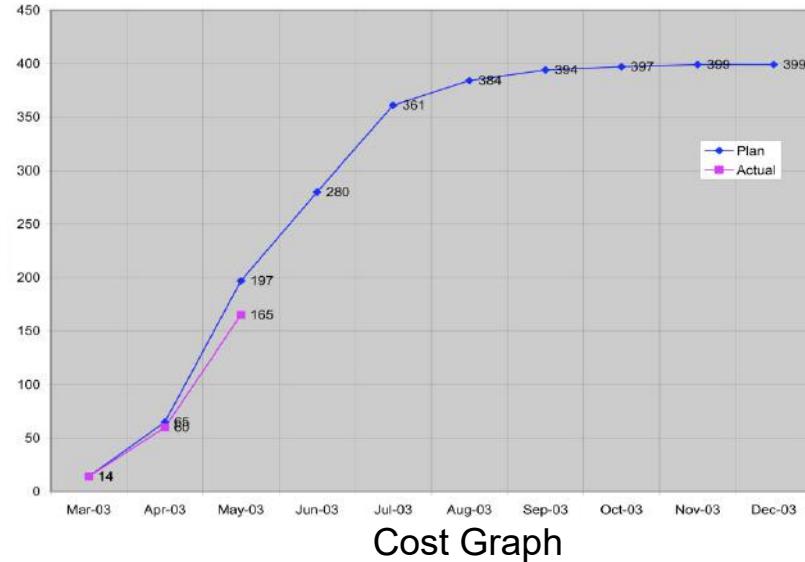
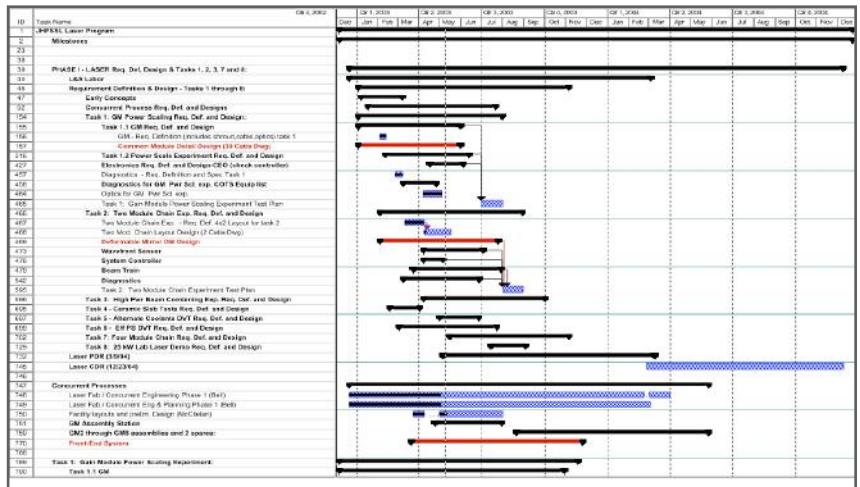
Engineering Projects are Difficult

- Problems are often *not completely solvable*
 - Conflicting requirements and stakeholders' motivations
 - Data that are incomplete, contradictory or non-existent
 - *Limitations of technology and physics, e.g. crash protection*
- Large number of *interrelated tasks*
- Many *different disciplines*
 - Technical
 - Non-technical
- *Diverse teams of people*
 - Organizing them and their work is difficult
 - Being simultaneously efficient and effective is difficult



AND YET we are able to define, perform and complete successful projects!
We do so through a combination of **organization and management**.

Project Management Tools



Project Management Is:



- An end in itself or a means to an end?
- Stifling creativity or freeing technical expression?
- Enabling or restricting?
- Boring or stimulating?

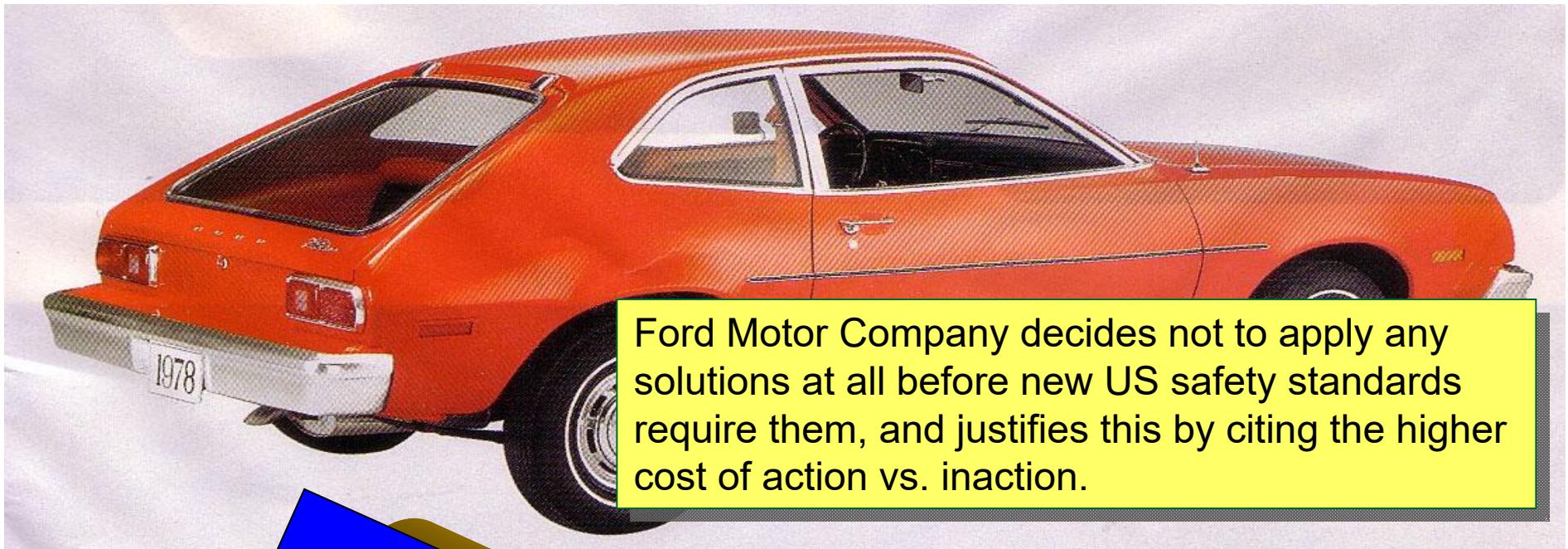
Both Inspirational Leadership *and* Responsible Management are required for complete success of small as well as large engineering projects.

Ethical Case Study 1: Expected Fires

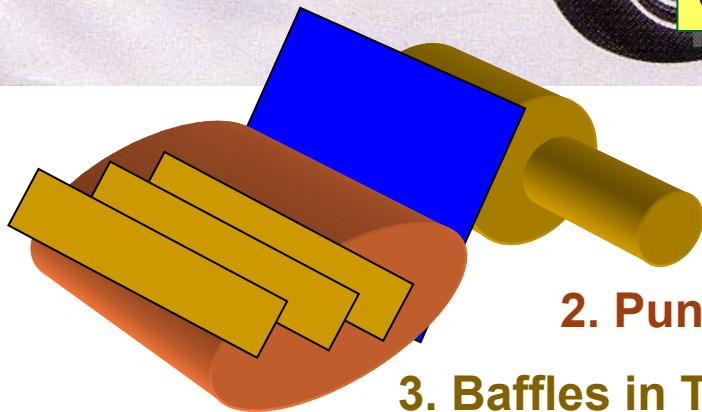


Ford is experiencing many fires as a result of rear end collisions. In the Pinto case, the gas tank moves forward into protruding bolts, causing frequent gas leaks, explosions, injuries and deaths.

Suggested Engineering Solutions



Ford Motor Company decides not to apply any solutions at all before new US safety standards require them, and justifies this by citing the higher cost of action vs. inaction.



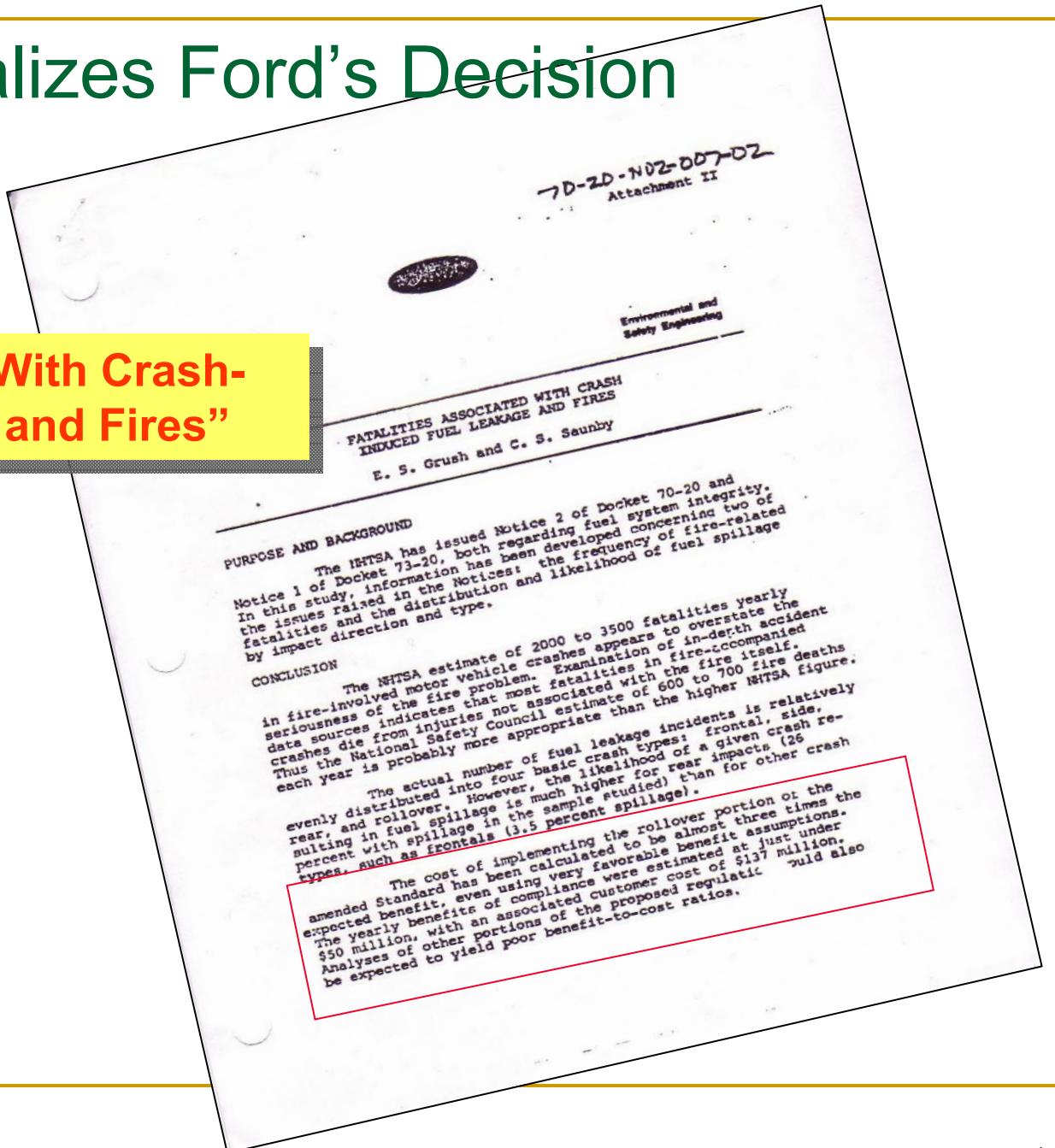
1. Protective Shield in Front of Bolts

2. Puncture-Proof Tank Material

3. Baffles in Tank

A Memo Rationalizes Ford's Decision

“Fatalities Associated With Crash-Induced Fuel Leakage and Fires”



Ford References “Cost/Benefit Analysis”

Benefits and Costs For Other Impact Modes

The analysis discussed above concerns only rollover consequences and costs. Similar analysis for other impact modes would be

The cost of implementing the rollover portion of the amended Standard has been calculated to be almost three times the expected benefit, even using very favorable benefit assumptions. The yearly benefits of compliance were estimated at just under \$50 million, with an associated customer cost of \$137 million. Analyses of other portions of the proposed regulation could also be expected to yield poor benefit-to-cost ratios.

Impact Factors

Concurred By:

J. D. Hromi
J. D. Hromi
Principal Staff Engineer

Ford's "Cost-Benefit Analysis" for the Industry

Table 3

BENEFITS AND COSTS RELATING TO FUEL LEAKAGE ASSOCIATED WITH THE STATIC ROLLOVER TEST PORTION OF FMVSS 208

BENEFITS:

Savings - 180 burn deaths, 180 serious burn injuries, 2100 burned vehicles.

Unit Cost - \$200,000 per death, \$67,000 per injury, \$700 per vehicle.

Total Benefit - $180 \times (\$200,000) + 180 \times (\$67,000) + 2100 \times (\$700) = \49.5 million.

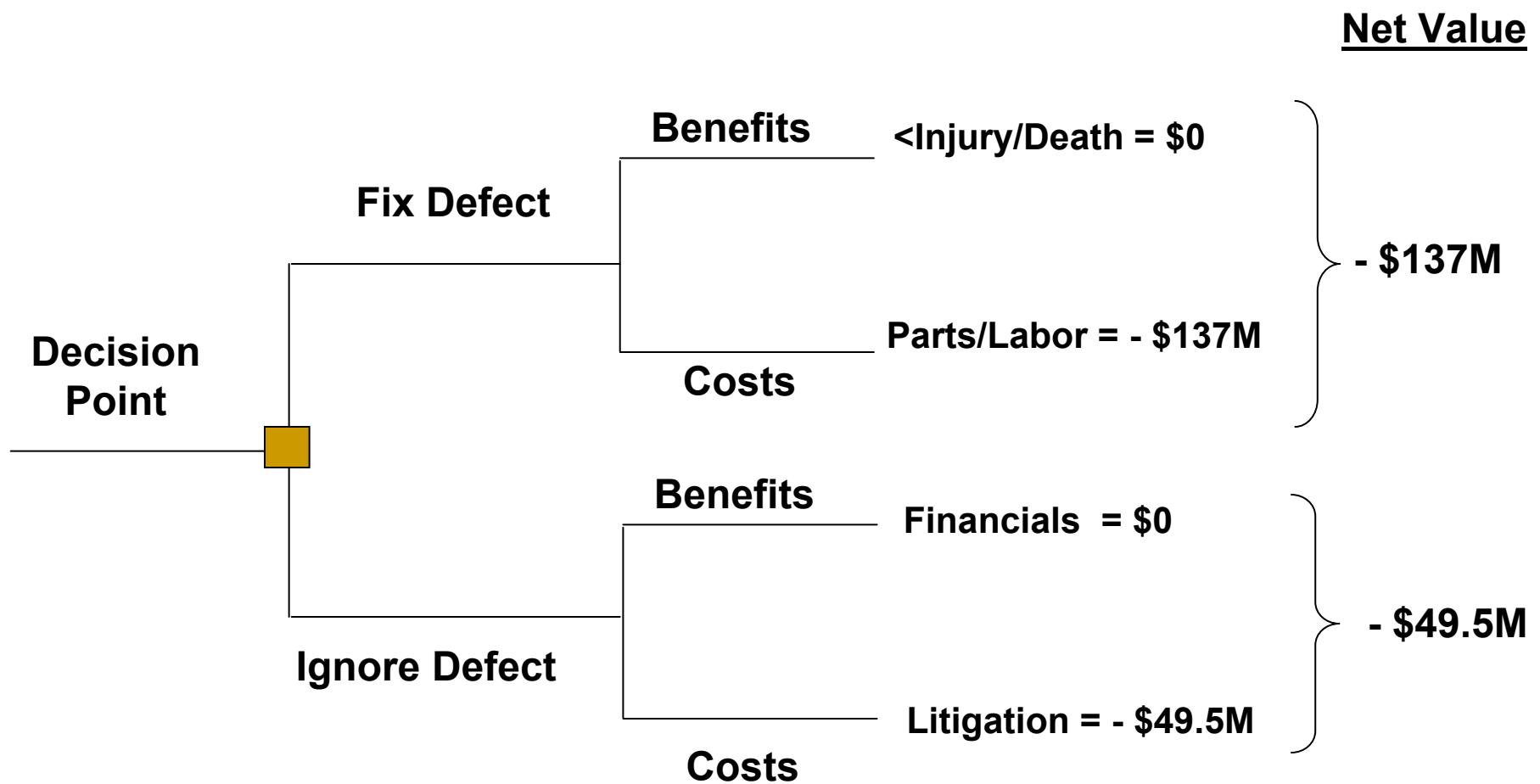
COSTS:

Sales - 11 million cars, 1.5 million light trucks.

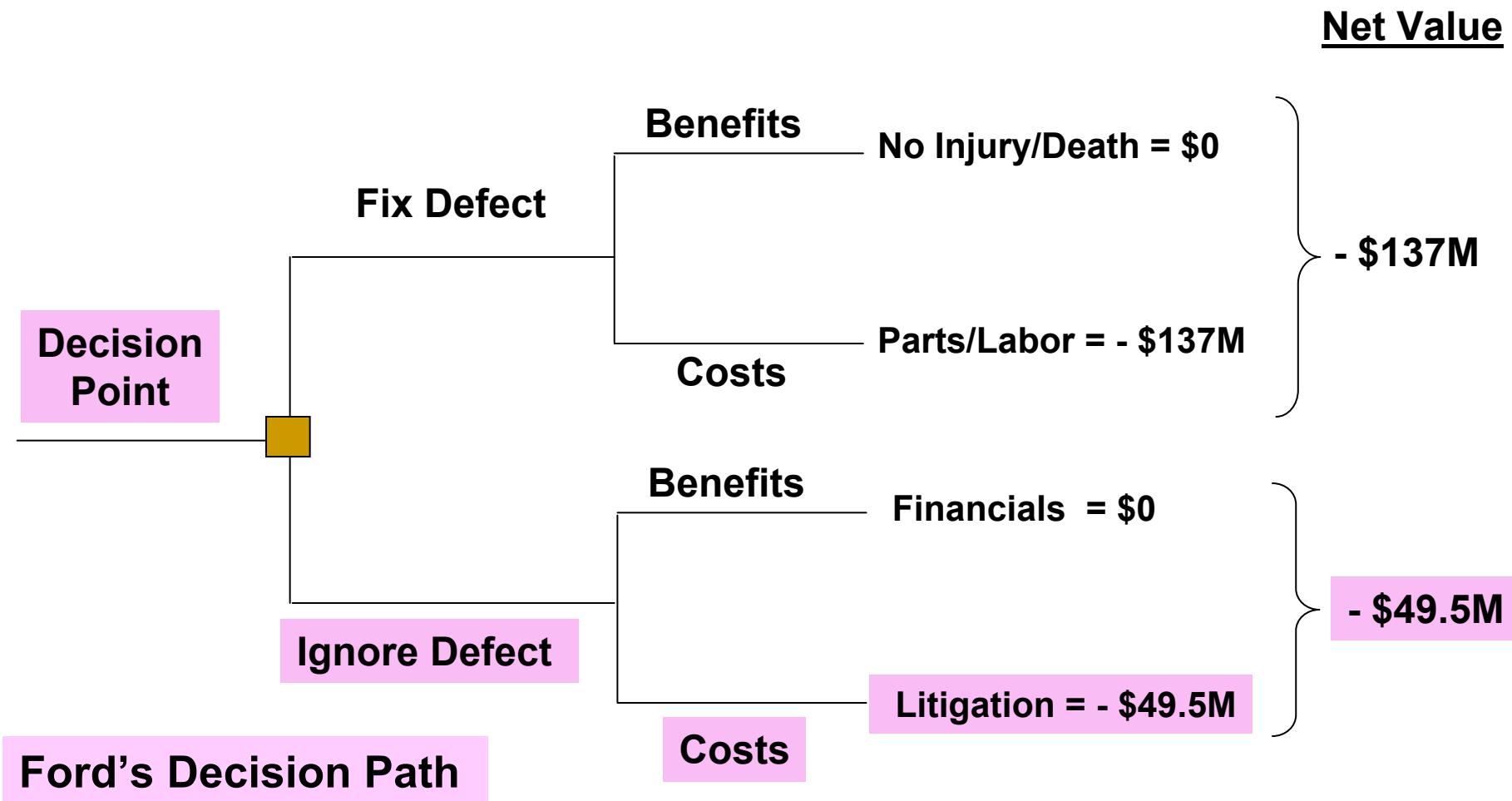
Unit Cost - \$11 per car, \$11 per truck.

Total Cost - $11,000,000 \times (\$11) + 1,500,000 \times (\$11) = \$137 \text{ million.}$

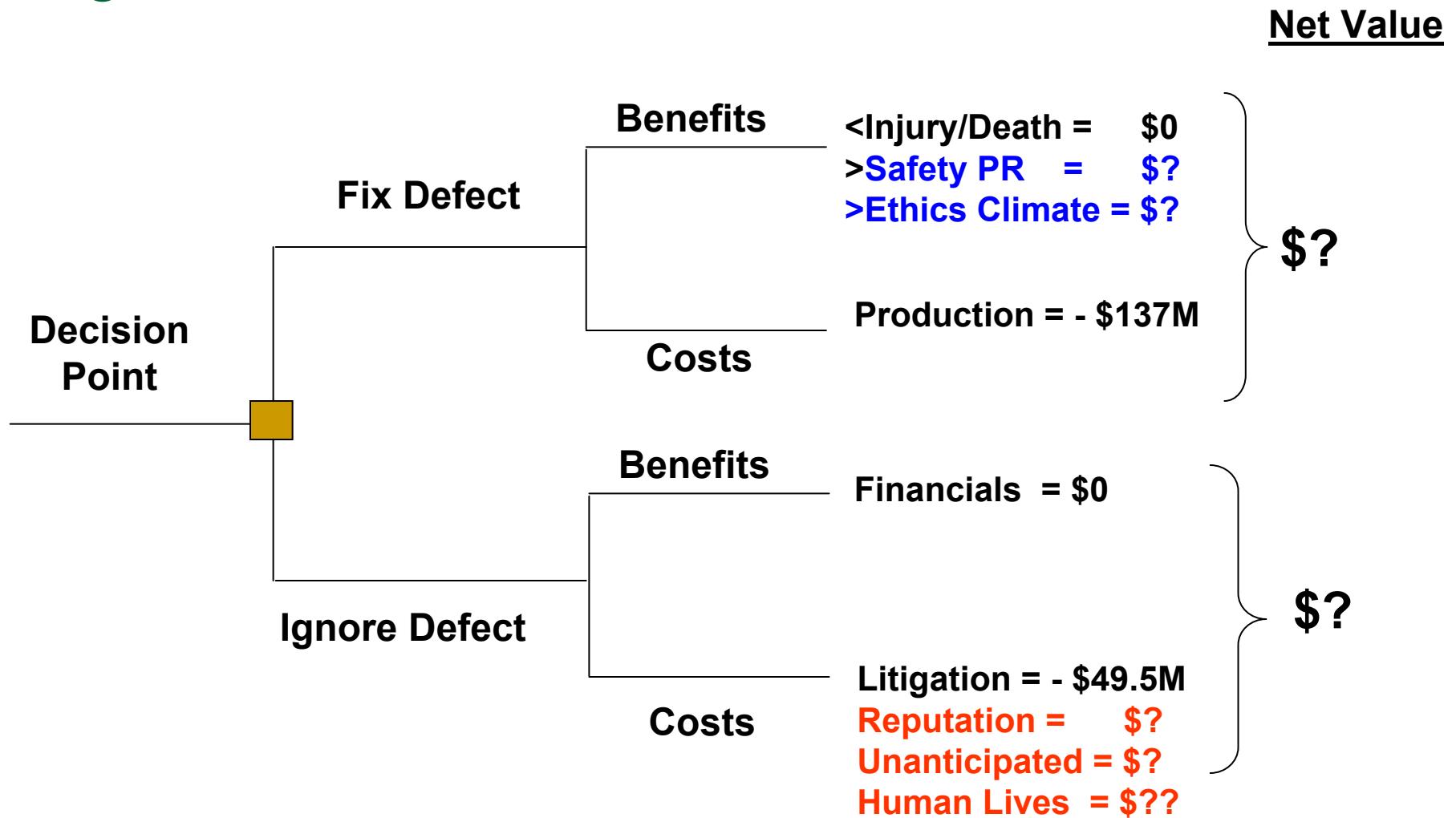
In Terms of a Decision Tree



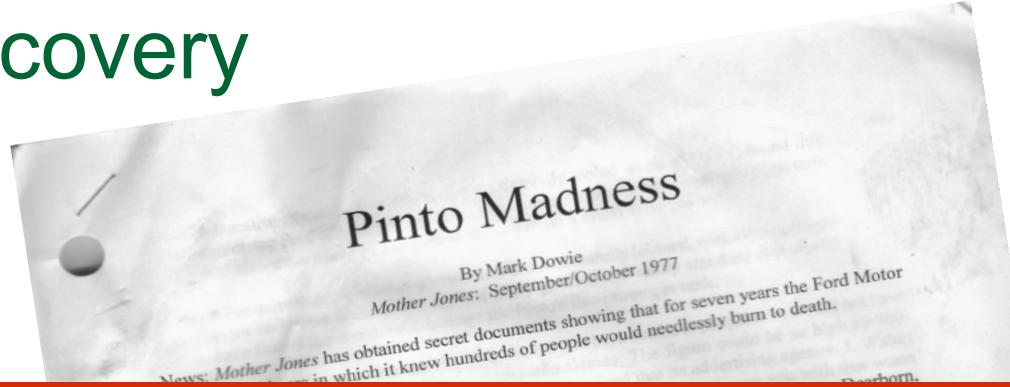
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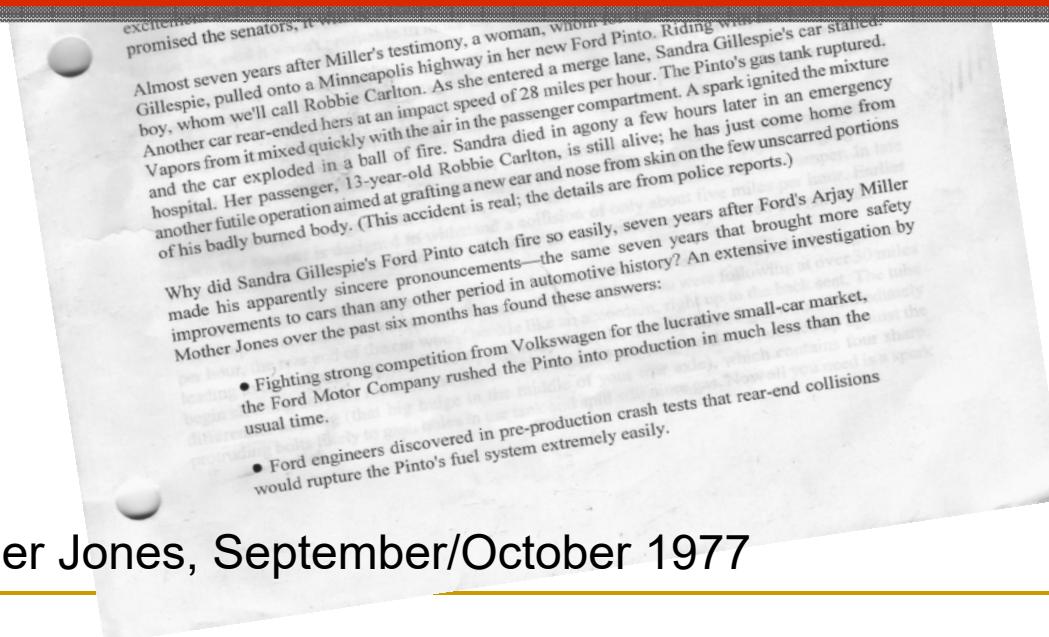
Neglected Decision Factors



Public Discovery



"News: Mother Jones has obtained secret documents showing that for seven years the Ford Motor Company sold cars in which it knew hundreds of people would needlessly burn to death."



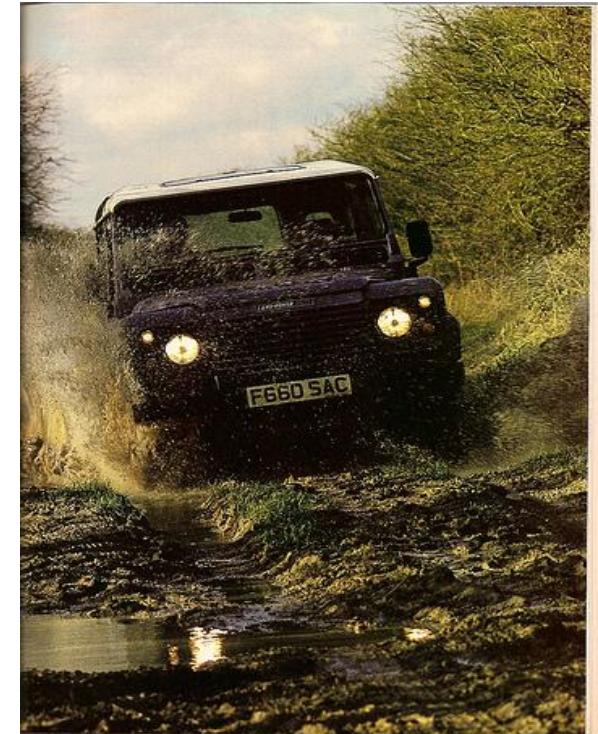
"Pinto Madness," Mother Jones, September/October 1977

Ethical Case Study 2: Expected Rollovers

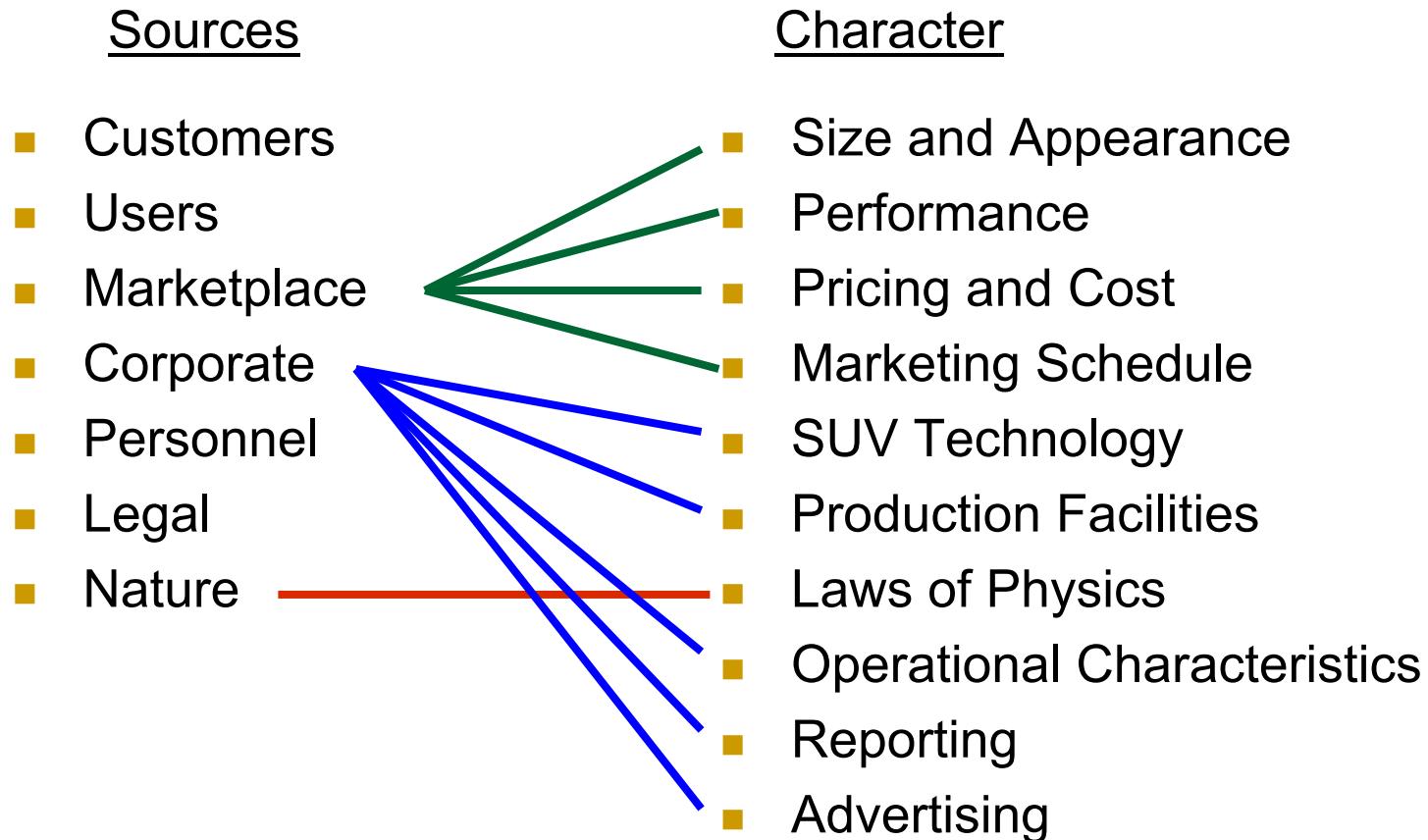
- The Engineering Project → 1991 Explorer SUV
- The Company → Ford Motor Company
- The Teams → Management, Engineering, Marketing
- The Main Ethical Issues → Safety versus Schedule and Cost
- The Results
 - Dangerous Vehicle → Deaths and Injuries
 - Much Litigation → Sample Lawsuit
- The Ethical Implication → The 'Bright Line' Between Ethical and Unethical Engineering Practice

Ford Explorer SUV Background

- 1989 Timeframe
- SUVs migrating to “Town & Country”
 - Rugged “off-road” looks
 - Tame suburban performance
 - Average family loads
 - Affordable family pricing
- Ford’s goal: Rapid entry into growing market
- Main decision options:
 - Develop a totally new “Urban SUV” product
 - Re-engineer an existing product
- Main decision factors:
 - Time to market – Want to make as short as possible
 - Production facilities – Want to use what’s available
 - Production cost – Want to make as low as possible



Explorer Requirements



Explorer Family Tree

1972-82 Courier LT



1983 Ranger LT

1984-90 Bronco II SUV



1989-96 Explorer SUV



For the Explorer, Ford used the same light pickup platform used before for the Ranger and Bronco II

Bronco and Explorer Comparison

	Bronco II (1989)	Explorer UN-46 (1990 Design)
Front Suspension	Twin I-beam independent	Twin I-beam independent
Rear Suspension	Hotchkiss underslung leaf spring	Hotchkiss underslung leaf spring
Steering	Recirculating ball	Recirculating ball
Wheel base (in)	94.0	111.9
Average track (in)	56.9	58.1
Curb weight (lb)	3371	3800
C.G. height (in)	26.7	27.6
SSF	1.07	1.07

Bronco and Explorer Comparison

	Bronco II (1989)	Explorer UN-46 (1990 Design)
Narrow track, poorly sprung Bronco II has a well known history of excessive rollover ¹	Twin I-beam independent	Twin I-beam independent
	Hotchkiss underslung leaf spring	Hotchkiss underslung leaf spring
Steering	Recirculating ball	Recirculating ball
Wheel base (in)	94.0	111.9
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Average track (in)	55.5
Curb weight (lb)	3371
C.G. height (in)	26.7
SSF	1.07

"NHTSA Investigates Bronco II Rollovers," Automotive News, 3/20/89

"Magazine Gives Ford's Bronco II 'Avoid' Rating," Wall Street Journal 5/8/89

"Bronco Performance Criticized," New York Times, 5/18/89

"Consumer Reports Criticizes Ford Bronco II's Handling," Washington Post, 5/18/89

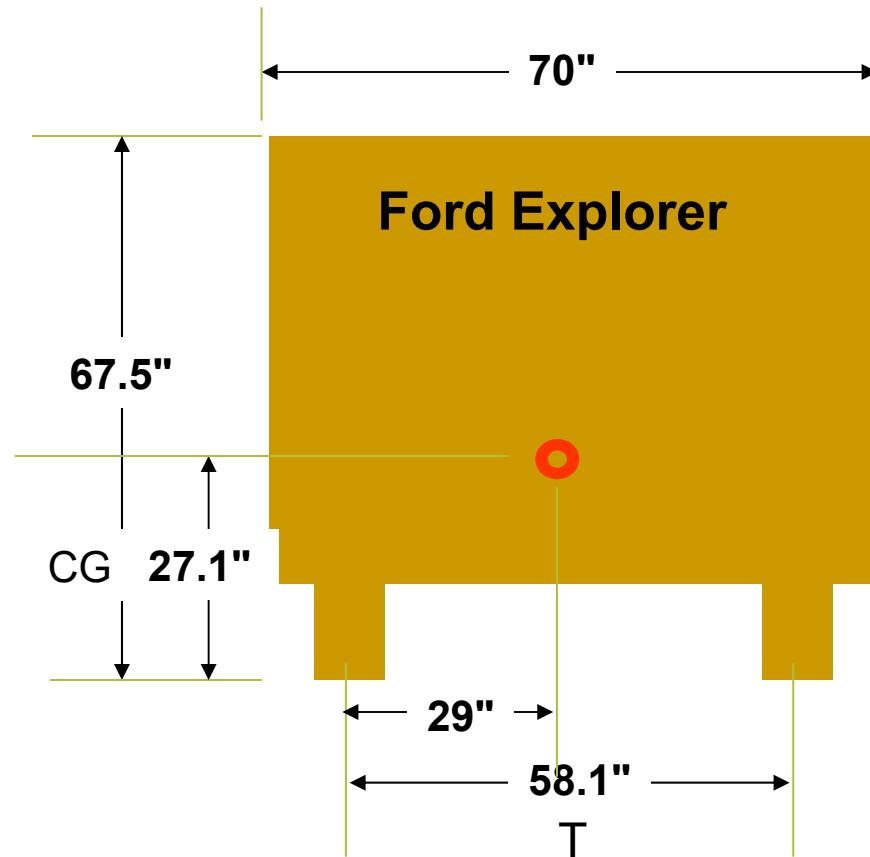
"Explorer: Ford's Bronco II Will be Renamed When Model Debuts Next Spring," Automotive News, 8/14/89

Bronco and Explorer Comparison

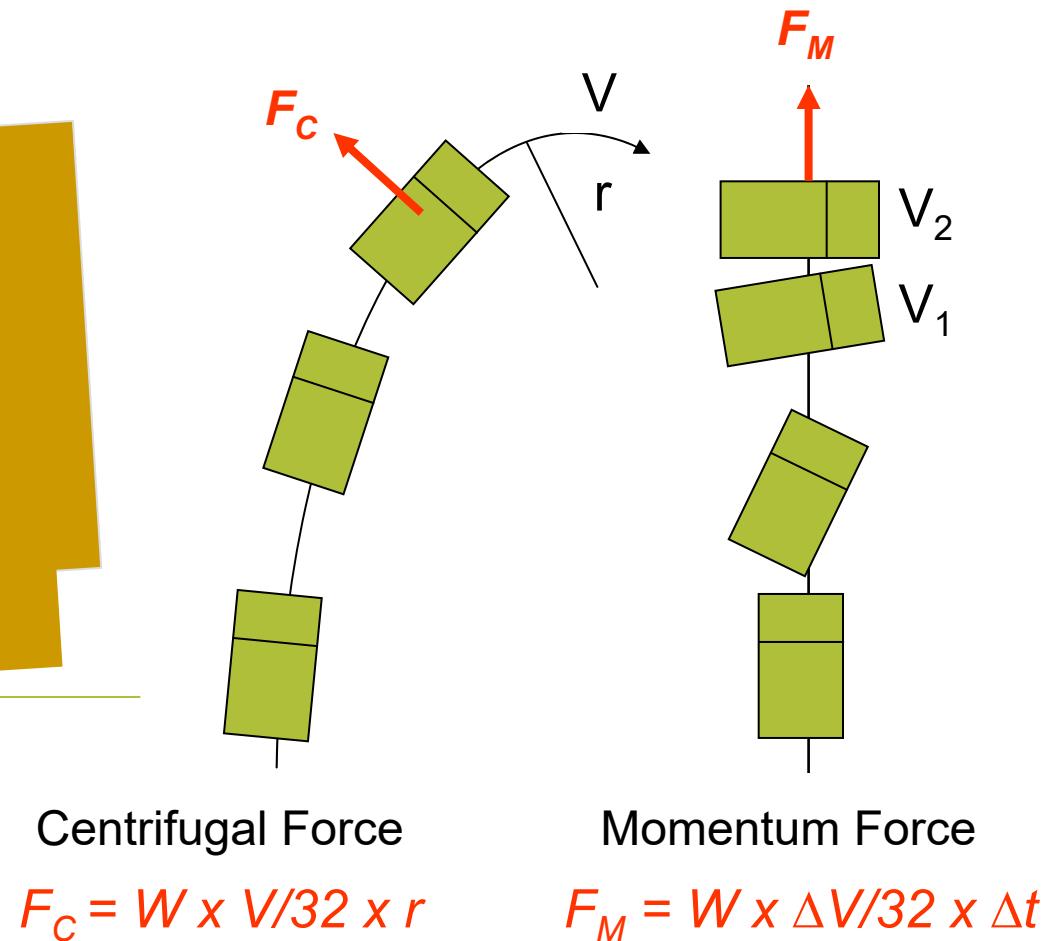
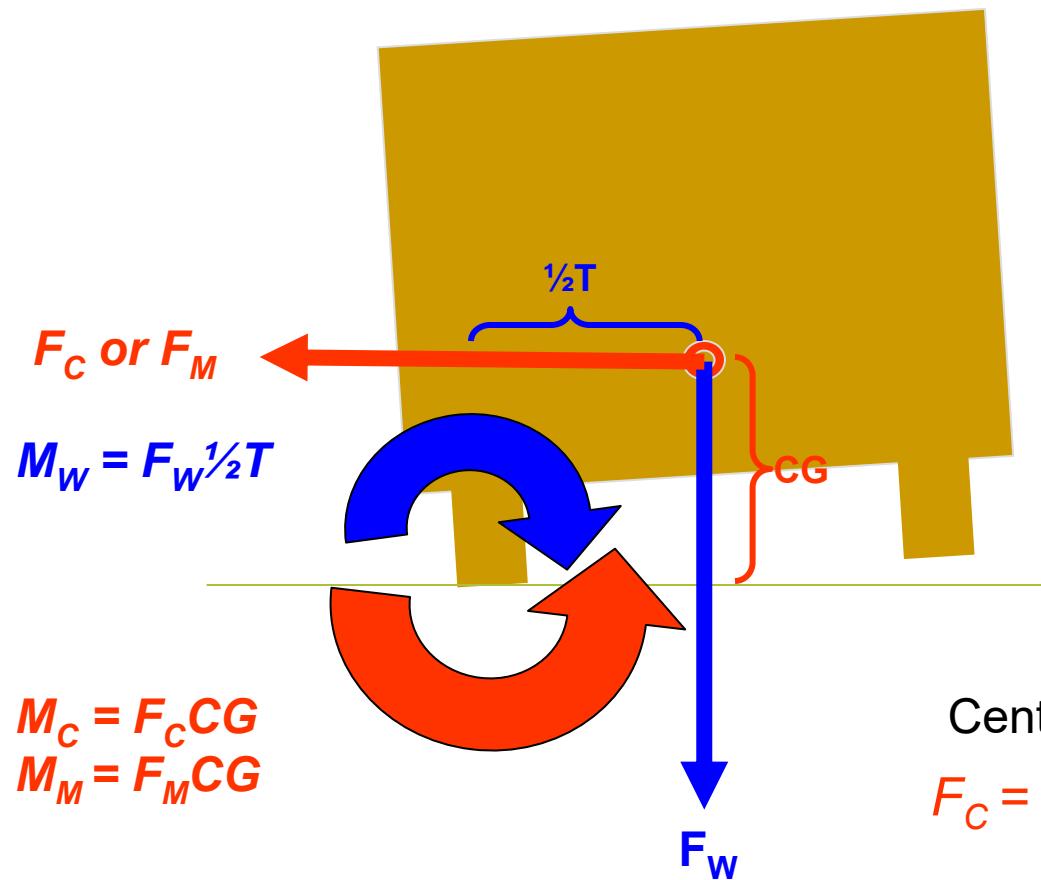
	Bronco II (1989)	Explorer UN-46 (1990 Design)	
Front Suspension ¹	Twin I-beam independent	Twin I-beam independent	Early engineering tests show that the narrow track, larger and heavier Explorer has the same type of rollover problem due to its identically low Static Stability Factor
Rear Suspension ¹	Hotchkiss underslung leaf spring	Hotchkiss underslung leaf spring	
Steering ¹	Recirculating ball	Recirculating ball	
Wheel base (in)	94.0	111.9	
Average track (in)	56.9	58.1	
Curb weight (lb)	3371	3800	
C.G. height (in)	26.7	27.6	
SSF	1.07	1.07	

Static Stability Factor (SSF)

$$\begin{aligned} \text{SSF} &= \frac{1}{2} (T/\text{CG}) \\ &= \frac{1}{2} (58.1/27.6) \\ &= 1.07 \end{aligned}$$

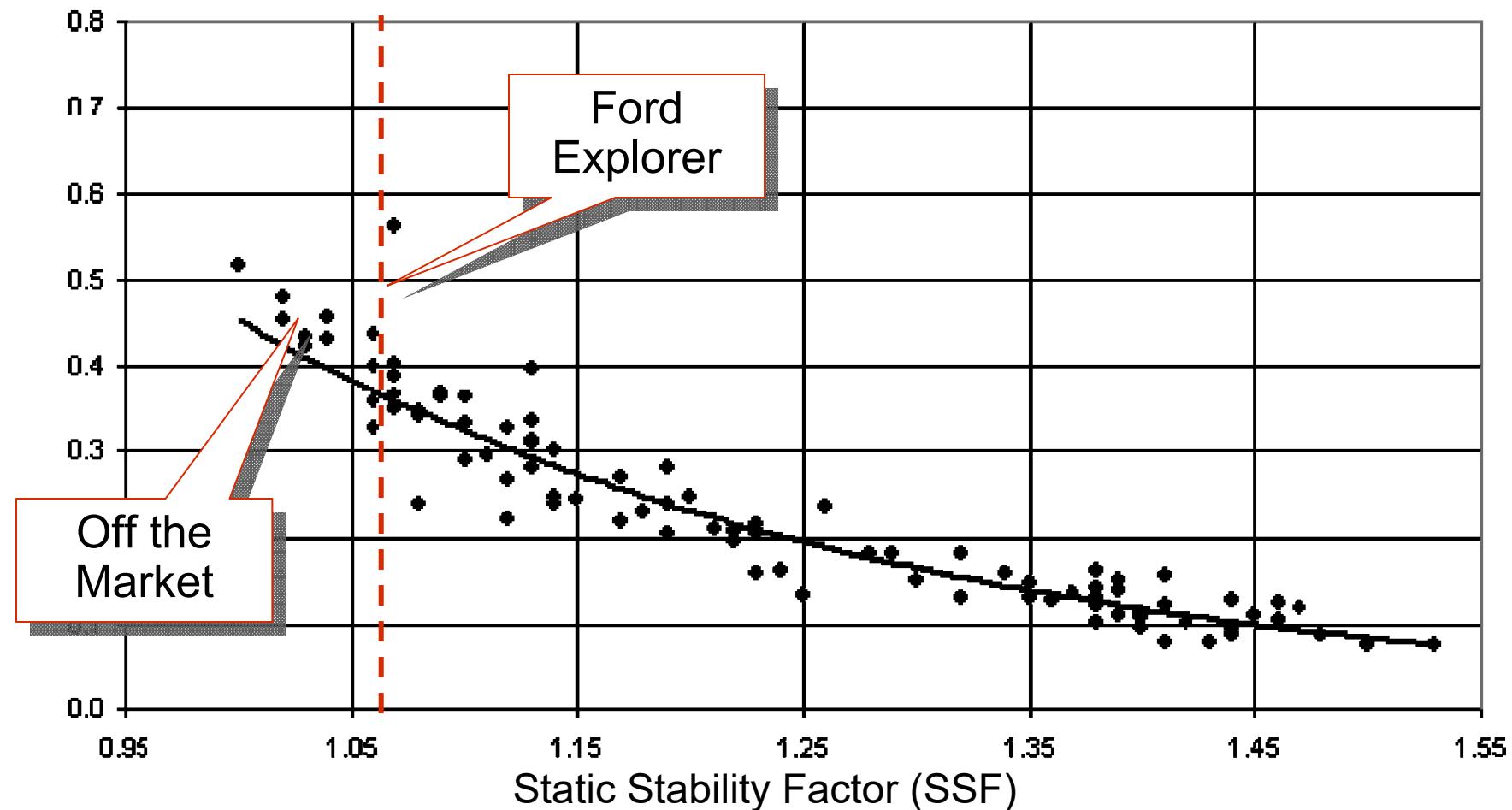


Inertial Rollover Forces & Moments



Effect of SSF on Probability of Rollover

Probability of Rollover in Single Vehicle Incident



NHTSA graph based on data from six states adjusted to national average road use

Ford's Response to Rollover Problem

Engineers recommend:	Management responds:
1. Lower the engine & CG	No. Too expensive and time consuming
2. Widen the Track	No. Would require new production line
3. Use smaller tires	No. Contrary to "rugged" SUV look
4. Stiffen the springs	Yes, Partially implemented
5. Lower the tire pressure	Yes. Recommend to service groups
6. Degrade performance	No. Contrary to marketing publicity

Management chooses Time and Cost over known Safety Problem!

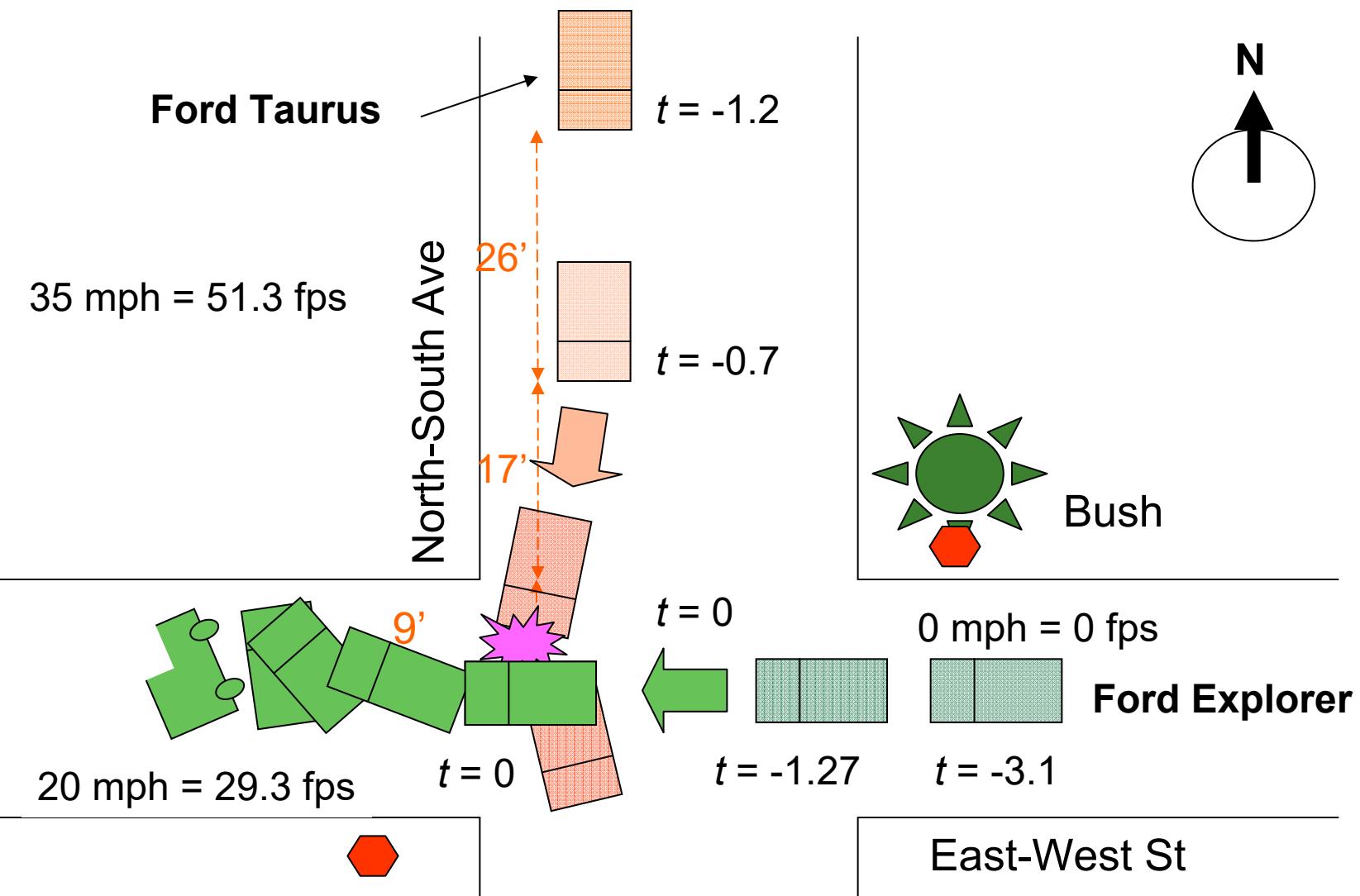
Ford Explorer Play-Out

- Explorer becomes best selling SUV in 1990s
- Thousands of death- and injury-causing rollover incidents
- 1996 partial redesign
 - Does not address fundamental Track and CG problems
 - Does not change SSF
 - Does not reduce the rate of rollovers
- 2000 Firestone tire problem exacerbates rollover problems
 - Production defects at Firestone plants
 - Lowered tire pressure increases rate of blowout and rollover
 - Firestone defense highlights low SSF and oversteer response
- Thousands of new ‘Explorer Rollover’ lawsuits
 - Damage judgments against Ford as high as \$22 million each
- 2002 Ford finally makes basic changes
 - Improves Track and Suspension
 - Raises SSF to 1.14

Typical “Explorer Rollover” Lawsuit

- Initial Positions of the Parties
 - Plaintiff claims simple fender-bender turned into a rollover with life-changing injury because of Explorer’s fundamental and previously known but unpublicized product defects
 - Ford claims that Explorer is safe vehicle, rollover was plaintiff’s fault or due to unique accident characteristics

Rollover Reconstruction



Urban Intersection Incident Site



Damage to Explorer



3D Simulation



3D Animation



Typical Rollover Lawsuit

- Initial Positions of the Parties
 - Plaintiff claims simple fender-bender turned into a rollover with life-changing injury because of Explorer's fundamental and previously known but unpublicized product defects
 - Ford claims that Explorer is safe vehicle, rollover was plaintiff's fault or due to unique accident characteristics
- Litigation Proceeds
 - Judge-ordered arbitration fails due to Ford's "low-ball" offer
 - Plaintiff submits pretrial motion to allow full presentation of Ford Bronco and Explorer safety history – Ford opposes
 - Judge rules against Ford on relevance of product history; allows full development history of Explorer and Bronco II
- Ford requests new arbitration, and Ford and Plaintiff settle out of court in compromise between initial offer and potential high jury award

Subsequent Results



November 29, 2007

Ford agrees to settle 'rollover' suit

- US auto giant Ford Motor Co said Wednesday it had reached a settlement in a class-action lawsuit lodged by people claiming the company's popular Explorer vehicle was prone to rollovers.
- A spokeswoman for Ford refused to give details of the settlement in an emailed statement to AFP, saying more information would be revealed when the deal is presented before a judge in Sacramento on Monday.
- "For the reasons that will be presented in court on Monday, we believe this settlement is fair and reasonable and is in the best interests of our customers and our shareholders," the spokeswoman said.
- Around one million people in four states -- California, Connecticut, Illinois and Texas -- had filed suit asserting that Explorers made between 1991 and 2001 were liable to rollover.
- Ford has battled a wave of wrongful death and injury lawsuits following accidents involving older models of the Explorer, regarded as Ford's flagship sports utility vehicle.

Lasting Repercussions

FORTUNE 75 KEY DECISIONS

A public still reeling from the betrayal of Watergate now learned that one of its great corporations, Ford Motor Co., had weighed the lives of consumers against the dollar—and chosen the dollar. Ford discontinued the Pinto in 1980 after a costly recall, but the blow to trust would prove more lasting. Consumer activists would now act as safety watchdogs. And when a California jury awarded a Pinto victim a then unheard-of \$125 million (later reduced to \$3.5 million) for pain and suffering, it galvanized class-action lawyers everywhere. — *Kate Bonamici*

“Biggest Business Decisions of the 20th Century,” Fortune, June 27, 2005, p.77

Auto Engineers Fight Back

1. Pinto no different from other compacts

Deaths per million vehicles		
	1975	1976
Gremlin	274	315
Vega	288	310
Datsun 1200/210	392	418
Datsun 510	294	340
Pinto	298	322
Corolla	333	293
VW Beetle	378	370

Data compiled by Gary T. Schwartz, "The Myth of the Ford Pinto Case," Rutgers Law Review, 1990-1991

In Gladwell's analysis, the engineers are focusing on technical issues,
and are totally ignoring the societal reactions to these particular accidents.

Malcolm Gladwell, "The Engineer's Lament," The New Yorker, May 4, 2015

People Reacted To Horrific Accident Reports



Graphic images of Pintos and other Ford cars burning and of badly burned victims.

Lesson Learned: The Story Matters

People have understood that small numbers with very compelling stories can carry more weight than larger numbers about “routine” deadly or injurious incidents.

“The death of one man is a tragedy, the death of millions is a statistic.”

Attributed in various forms to:

Eric Maria Remarque

German WWI veteran and author, *Der Schwarze Obelisk*, 1956

Joseph Stalin

Russian dictator, to US ambassador Averill Harriman, ~1947

Kurt Tucholsky,

German journalist in *Franzosischer Witz*, 1932

Ethical Case Study 3: Boeing 737 MAX



In early 2019 consecutive crashes of Boeing 737 MAX aircraft in Indonesia and Ethiopia focused attention on deficiencies in design, notification and training.

737 MAX Main Problems

- Marginal design concept
- Over-trust in automation
- Deficient UX design
- Ignoring engineering concerns
- Self certification
- Misleading information to customers and airline pilots
- Insufficient training program

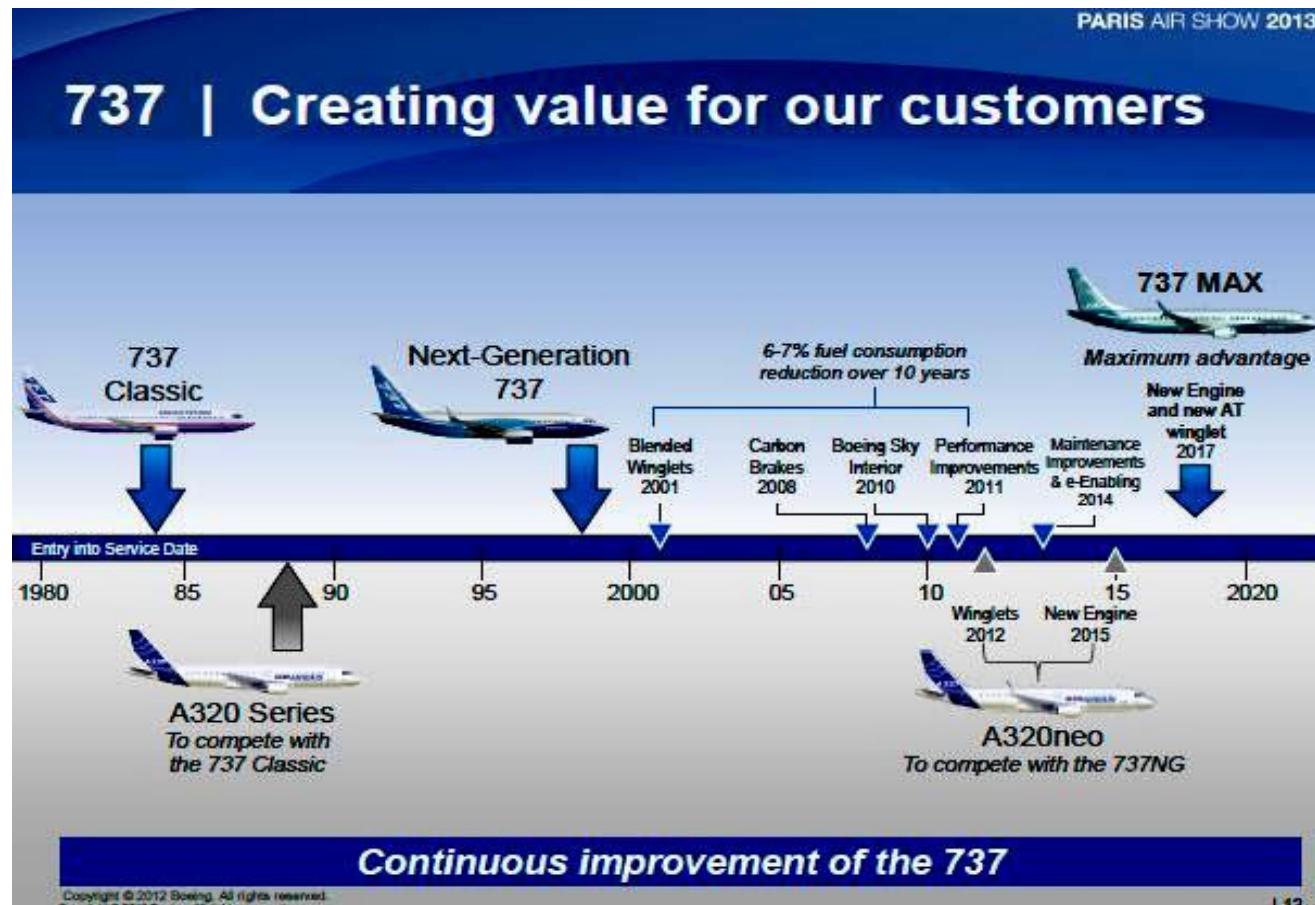
The 737 MAX was a perfect “ethical storm” of incompetence and mismanagement.

737 Classic Configuration



The Series 737 aircraft was originally designed low to the ground so that a built-in stairway could be used by crew and passengers at less developed airports.

737 Product Evolution



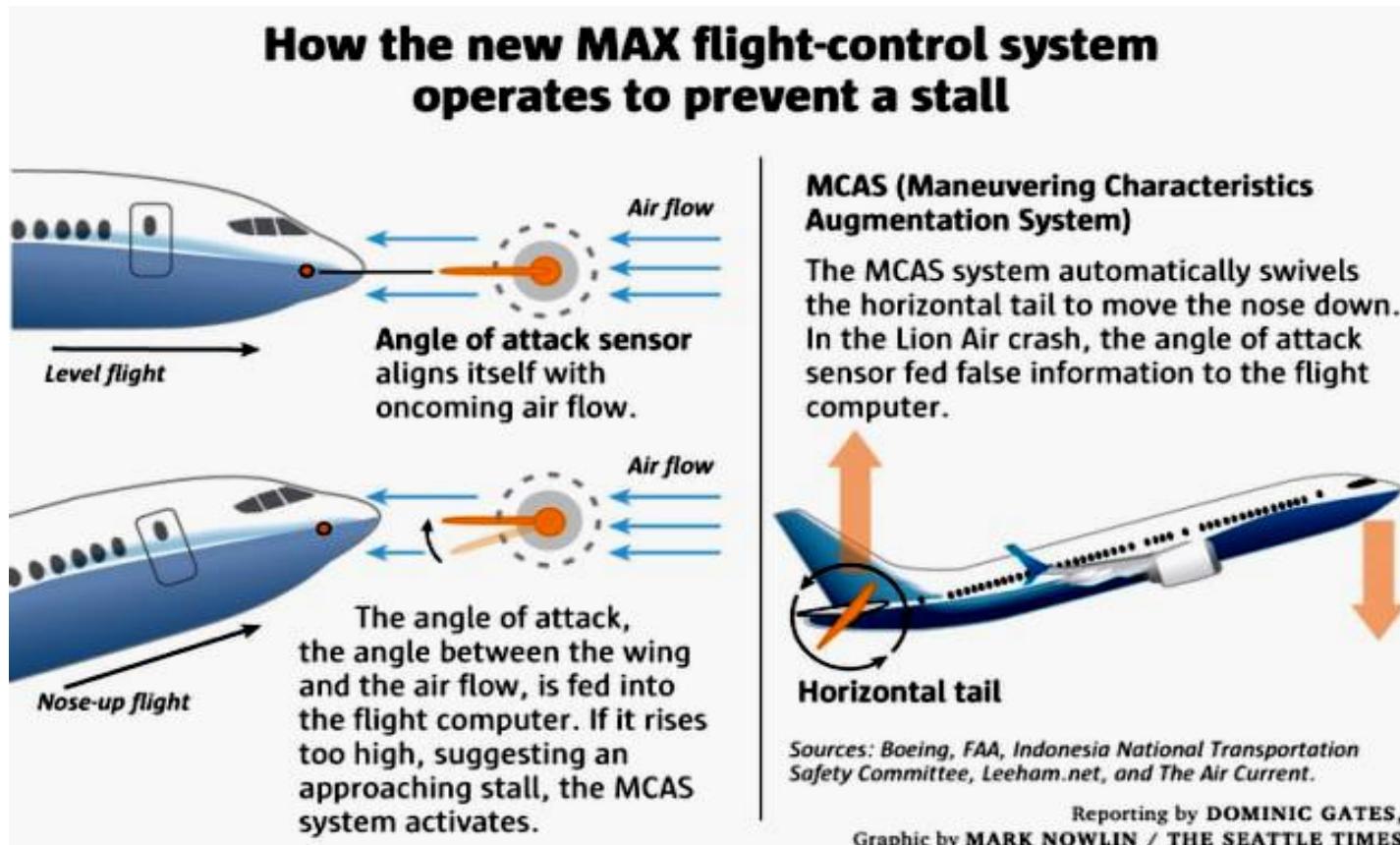
The success of the 737 Classic model led to Boeing building a number of Next Generation versions with increasingly greater seating capacity, power and range.

737 MAX Engine Upgrade



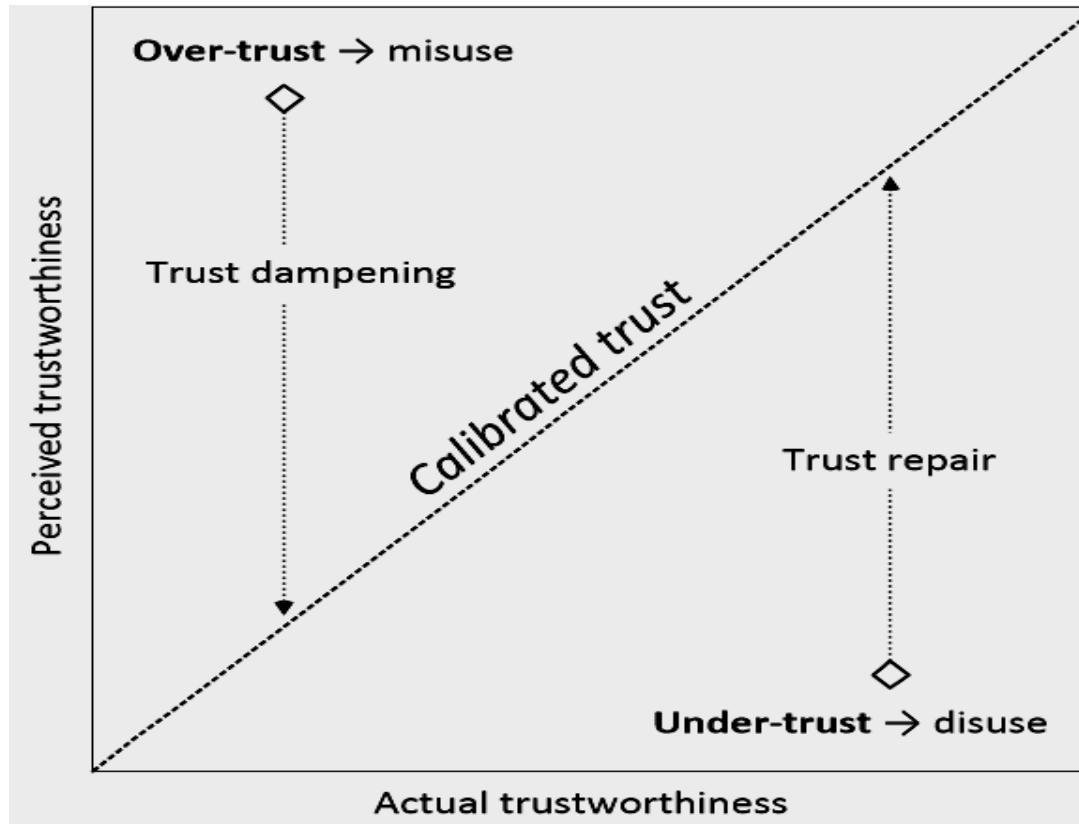
The most recent 737 MAX has much larger engines, which required a more forward position for ground clearance, and tended sometimes to pitch the nose upward.

MCAS “Nose Up” Compensation



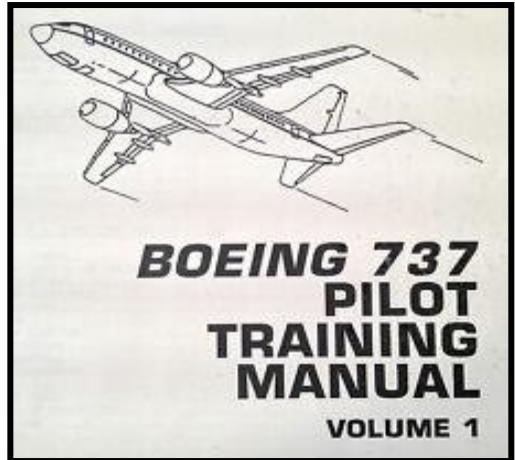
Boeing installed “MCAS” automation to compensate for detected impending stalls due to excessive nose up, but did not adequately test the addition to 737 operation.

Trust in Automation



In the case of the 737 MAX, the over-trust occurred with the automation designers and implementers rather than with the users, as is more usual.

Deficient Representation, UX and Training



- MAX was presented as just like previous models
- MCAS was downplayed to a few lines in the manual
- Sensor problem alerts were extras in purchase
- Boeing fought need for simulator training
- Actual MCAS alarms were loud and confusing
- Result was total confusion in pre-crash situations when MCAS had activated

Hurried & Incompetent Self-Certification



FAA ceded certification to Boeing employees who:

- Were unduly pressured to approve design changes
- Did not follow their own rules
- Used outdated procedures
- *Lacked the resources and expertise to fully validate the design changes associated with the MCAS*



According to a panel of global aviation safety experts convened by the FAA as reported October 11, 2019

Engineers Were Highly Critical...

- ❑ “Would you put your family on a Max simulator trained aircraft?” “I wouldn’t. No.”
- ❑ “I still haven’t been forgiven by God for the covering up I did last year.”
- ❑ “Am not lying to the FAA. Will leave that to people who have no integrity.” “I’m sorry, that is not acceptable. Your integrity is priority 4.”
- ❑ **“I’ll be shocked if the FAA passes this turd.”**
- ❑ **“This airplane is designed by clowns who in turn are supervised by monkeys.”**
- ❑ **“I just jedi mind tricked these fools. I should be given \$1,000 every time I take one of these calls. I save this company a sick amount of \$\$\$\$.” “what did you convince them of?” “to make them feel stupid about trying to require any additional training requirements” (i.e., beyond laptop based training)**

2017-2018 internal emails released by Boeing during investigation

... and Also Had a Solution

787 Synthetic Airspeed

- Calculated from angle of attack and inertial data
 - AOA – voted dual sensors plus inertial data
 - Accurate Coefficient of Lift (C_L)
 - Airplane Mass from FMC - Validated after Takeoff
- Algorithm developed for enhanced stall protection
- Avoid displaying data known to be bad
 - Loss of valid voted V_{CAS} = Display synthetic airspeed
 - Loss of valid voted P_{STATIC} = Display GPS altitude

© The Boeing Company

Engineer Curtis Ewbank said in a memo:

- Airspeed and AOA are critical data
- 737 MAX MCAS used standard sensors
- Standard sensors often in error
- 737 MAX cockpit analysis revealed potentially serious safety problems
- 787 Dreamliner has Synthetic Airspeed computation system as backup to data from standard sensors
- Engineers recommended installation of Synthetic Airspeed to increase safety
- **Management refused; the decision reflected a corporate culture of**
 - **Cost/schedule over safety/quality**
 - **Ignoring engineers' proposals**

Installation of Synthetic Airspeed would have prevented 737 MAX crashes

The Result

Between Two Mistrust

IANNAI BEDOJA and MUKUTTA SUTHA
April 1, 2019



Tension and

SEVERAL U.S. airlines said the upgrades to the 737 Max announced by Boeing appeared to be adequate. Above, Southwest 737 Max jetliners in Victorville.

Boeing says it'll update key 737 Max software

In response to crashes, it will also boost pilot training, make air flow data display standard.

BY SAMANTHA MASUNAGA, RICHARD READ AND RALPH VARTABEDIAN

Boeing Co. will modify the flight control system of its 737 Max jetliner so its software cannot send the aircraft into a series of uncontrolled dives, as it may have done in two crashes over the last five months, the company said Wednesday.

In an additional step, Boeing will also recommend increased pilot training and make standard a cockpit display of data from air flow sensors outside the plane.

The changes are Boeing's attempt to respond to preliminary findings that auto-

mated features in the 737 Max's flight control system may have contributed to two fatal crashes: a Lion Air flight in Indonesia that killed 189 people in October and an Ethiopian Airlines flight in March that killed 157.

The company and its federal regulators have been criticized for responding slowly to potential similarities in the two crashes. As one country after another grounded hundreds of 737 Max planes, the Federal Aviation Administration and Boeing delayed acting in the U.S. Boeing has repeatedly said the 737 is safe, and a company vice president reiterated that sentiment during a Wednesday media briefing in Renton, Wash.

Several U.S. airlines said the announced upgrades to the 737 Max appeared to be adequate. But Boeing may have suffered lasting damage to its reputation from its

slow response, one aviation safety expert said.

"Had all these mitigations that are now being identified been implemented in the initial release of the aircraft, then we would not be here," said Thomas Anthony, director of USC's Viterbi Aviation Safety and Security Program. "They're going to need to invest a great deal of time and energy in reestablishing their reputation for integrity."

Boeing didn't say how soon the software change would be implemented. But it requires approval by the FAA and foreign aviation regulators, and no timetable has been set. The impact on airlines was quantified Wednesday when Southwest Airlines, the largest user of the 737 Max planes, said the groundings along with weather and labor issues had forced cancellation [See Boeing, A12]



The Result

Trans MARKETSINSIDER WATCHLIST Q

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Boeing's reputation has been stained by the 737 Max and it's going to have to fight to convince people the plane is safe (BA)

Benjamin Zhang

© Apr. 11, 2019, 10:50 AM

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Finally..Resolution

New software and training make the jet safe, FAA says after a 20-month grounding.

LA Times November 19, 2020

Boeing's 737 Max gets OK to fly again

New software and training make the jet safe, FAA says after a 20-month grounding.

BY DAVID KOENIG AND TOM KRISHER

Nearly two years after a pair of deadly crashes, the U.S. Federal Aviation Administration has cleared Boeing's 737 Max for flight.

The nation's air safety agency announced the move Wednesday, saying it made the decision after a "comprehensive and methodical" 20-month review process.

Regulators around the world grounded the Max in March 2019 after the crash of an Ethiopian Airlines jet. That happened less than five months after a Max flown by Indonesia's Lion Air plunged into the Java Sea. A total of 346 passengers and crew members on the planes were killed.

FAA Administrator Stephen Dickson signed an

order Wednesday rescinding the grounding. U.S. airlines will fly the Max once Boeing updates crucial software and computers, and pilots receive training in flight simulators.

The FAA says the order was made in cooperation with air safety regulators worldwide.

The move follows exhaustive congressional hearings on the crashes that led to criticism of the FAA over alleged lax oversight and Boeing, which was accused of rushing to implement a new software system that put profit over safety and ultimately led to the firing of the company's chief executive.

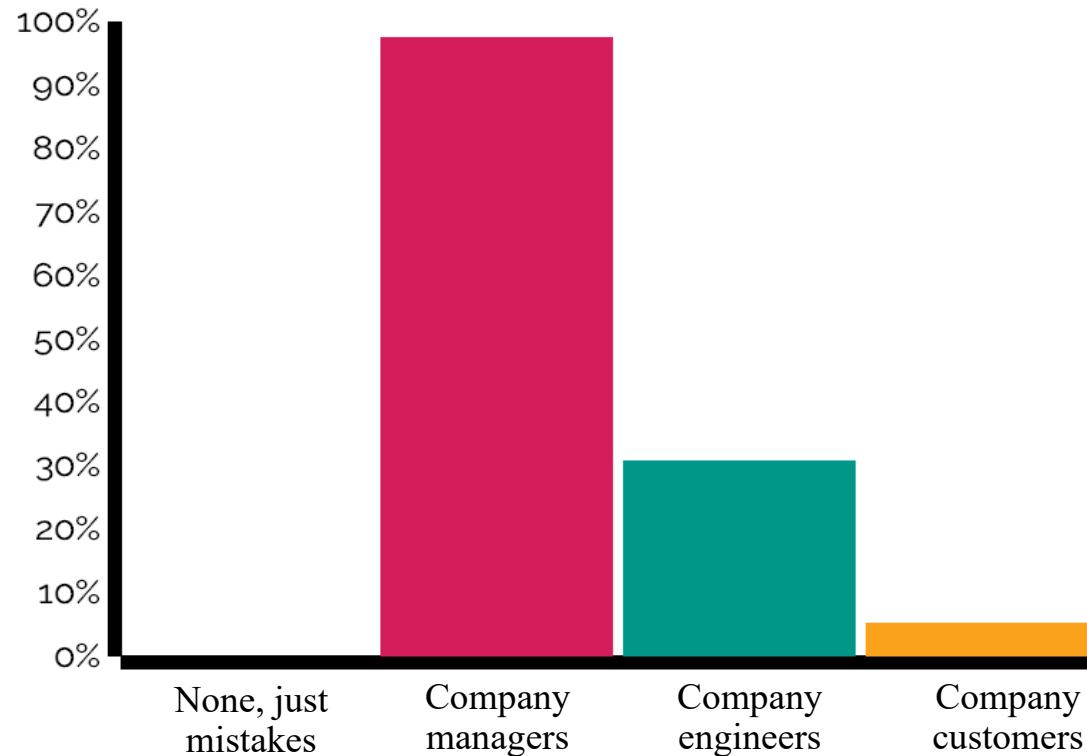
Investigators focused on anti-stall software that Boeing had devised to counter the plane's tendency to tilt nose-up because of the size and placement of the engines. That software pushed the nose down repeatedly on both planes that crashed, overcoming the pilots' struggles to regain control. In [See 737 Max, A11]

Online Poll: Who's at Fault?

- Log in to UCLA_WIFI or UCLA_WEB
- Go to <https://onlinepoll.ucla.edu>
- Search for Engr183EW–Who's at Fault
- Password - 1234
- Answer the 1 multiple choice question
- Hit “SUBMIT”
- Finish in 3-5 minutes

Online Poll: Who's at Fault?

Which group of people is mainly responsible for the deaths and injuries caused by the Ford and Boeing vehicles?



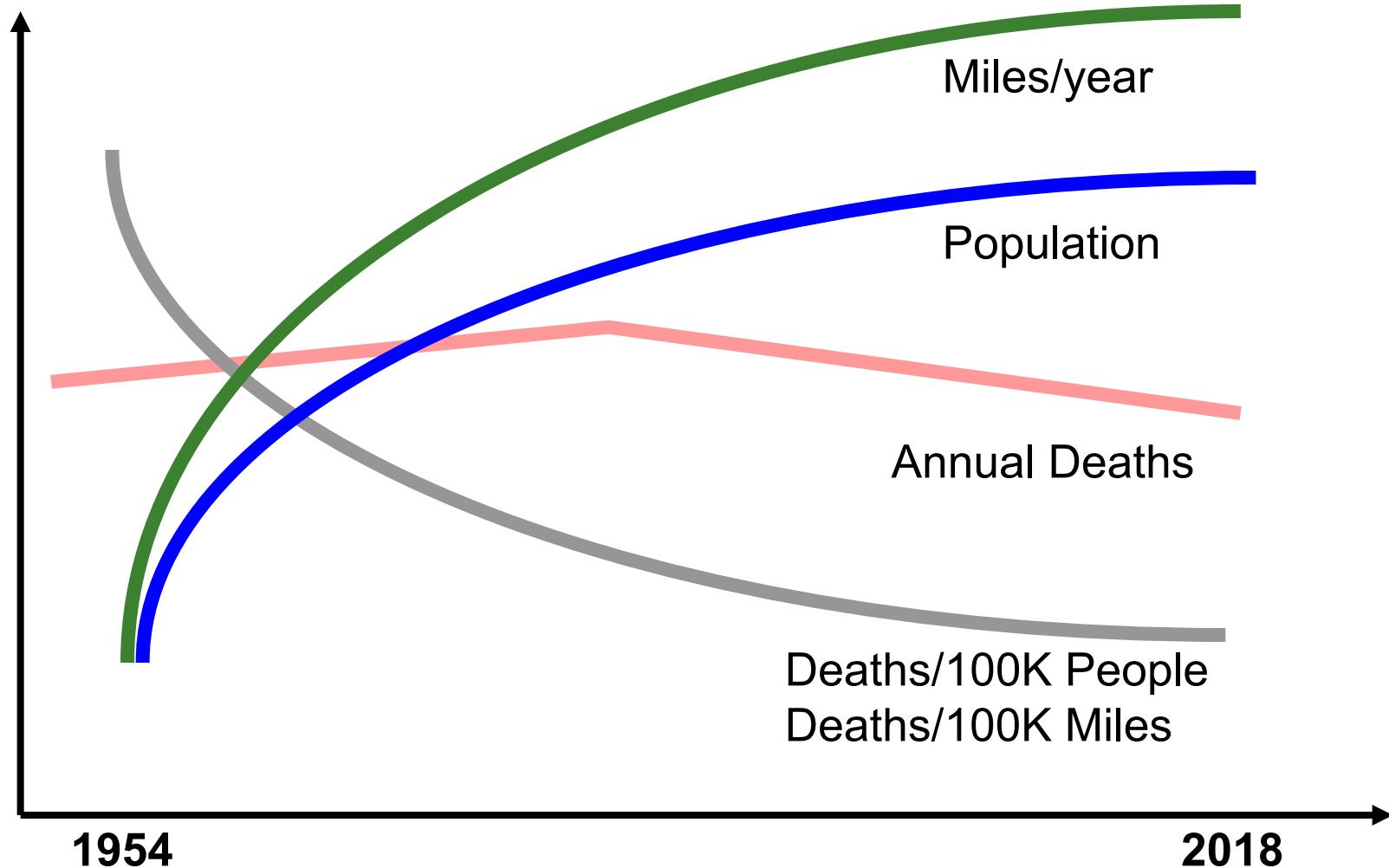
Company managers certainly get overwhelming blame, but the class also recognizes that the engineers have responsibility, and even the customers.

“Acceptable Risk” Influences Decisions

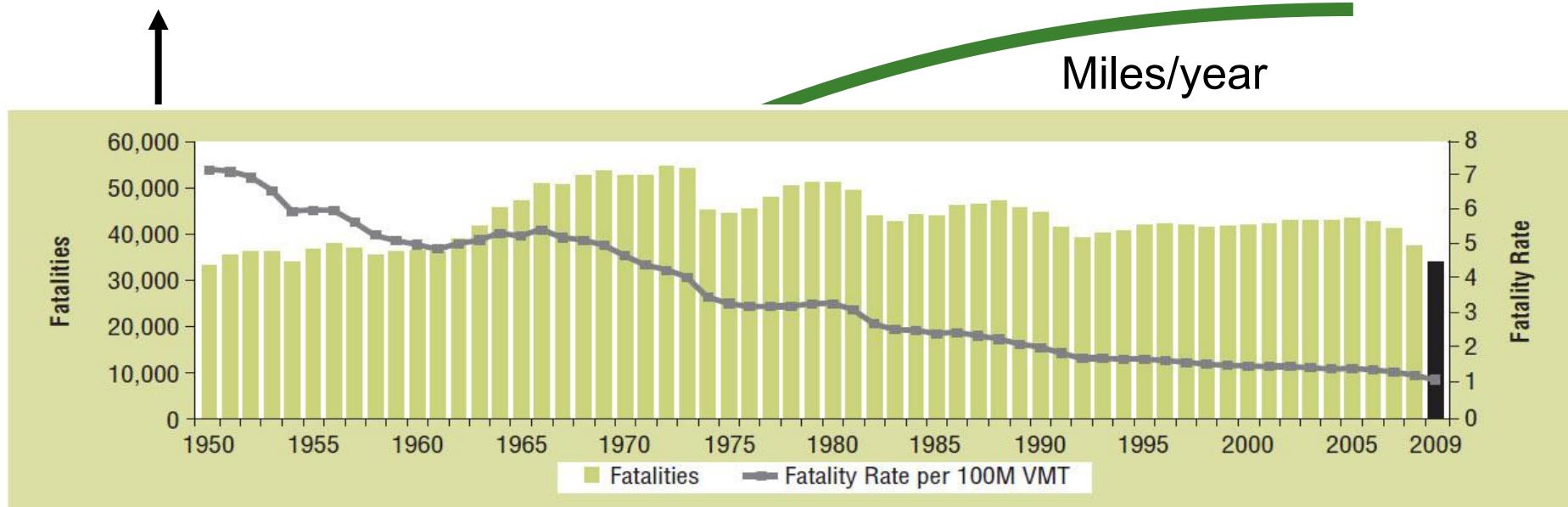
- Generally not the result of deep knowledge
- Choices involved are often hidden or obscure
- Actual risk tolerance often differs from stated positions
- Statistics may best reflect the “real” societal priorities

Acceptable Risk is the societal equivalent of Expectation of Privacy.
It is based both on historical and changing technological factors.

For Example: U.S. Deaths in Cars



For Example: U.S. Deaths in Cars



1950-1974: National Center for Health Statistics, HEW, and State Accident Summaries (Adjusted to 30-Day Traffic Deaths by NHTSA); FARS 1975-2008 (Final), 2009 Annual Report File (ARF); Vehicle Miles Traveled (VMT): Federal Highway Administration.

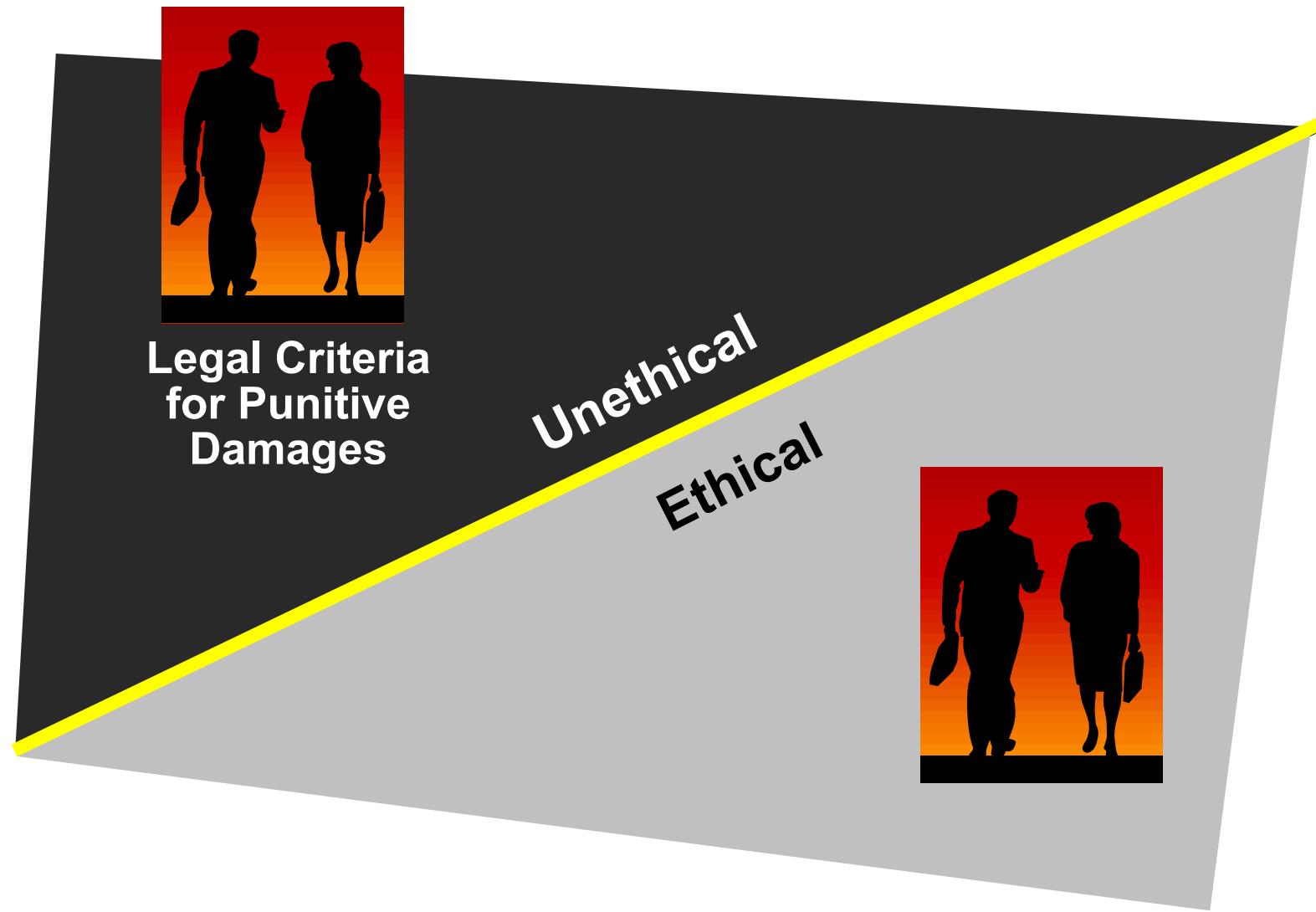
Deaths/100K People
Deaths/100K Miles

Fatality number remains relatively steady because Americans are apparently willing to accept this as the price of driving fast on rather old fashioned roads.

Some Relevant Ethical Questions

- Can we put a *dollar value on death and injury*? Do we now?
- Can we *ethically ignore* some safety problems? Do we now?
- Can we *include all safety related factors and likely societal reactions* in engineering decisions? Do we now?
- Can the public be *properly informed* of decisions that affect its safety? Is that now the case?
- **Is there a “*Bright Shining Line*” between legitimate engineering failures and unethical engineering conduct?**

The Bright Line Concept



Legal Criteria for Punitive Damages

- Malicious
 - Prior knowledge
 - Harmful intent
- Fraudulent
 - False representation
 - Suppression of true facts
- Oppressive
 - Imposition of power
 - Denial of basic rights

Example Engineering Failure

Design errors are blamed in Minnesota bridge collapse

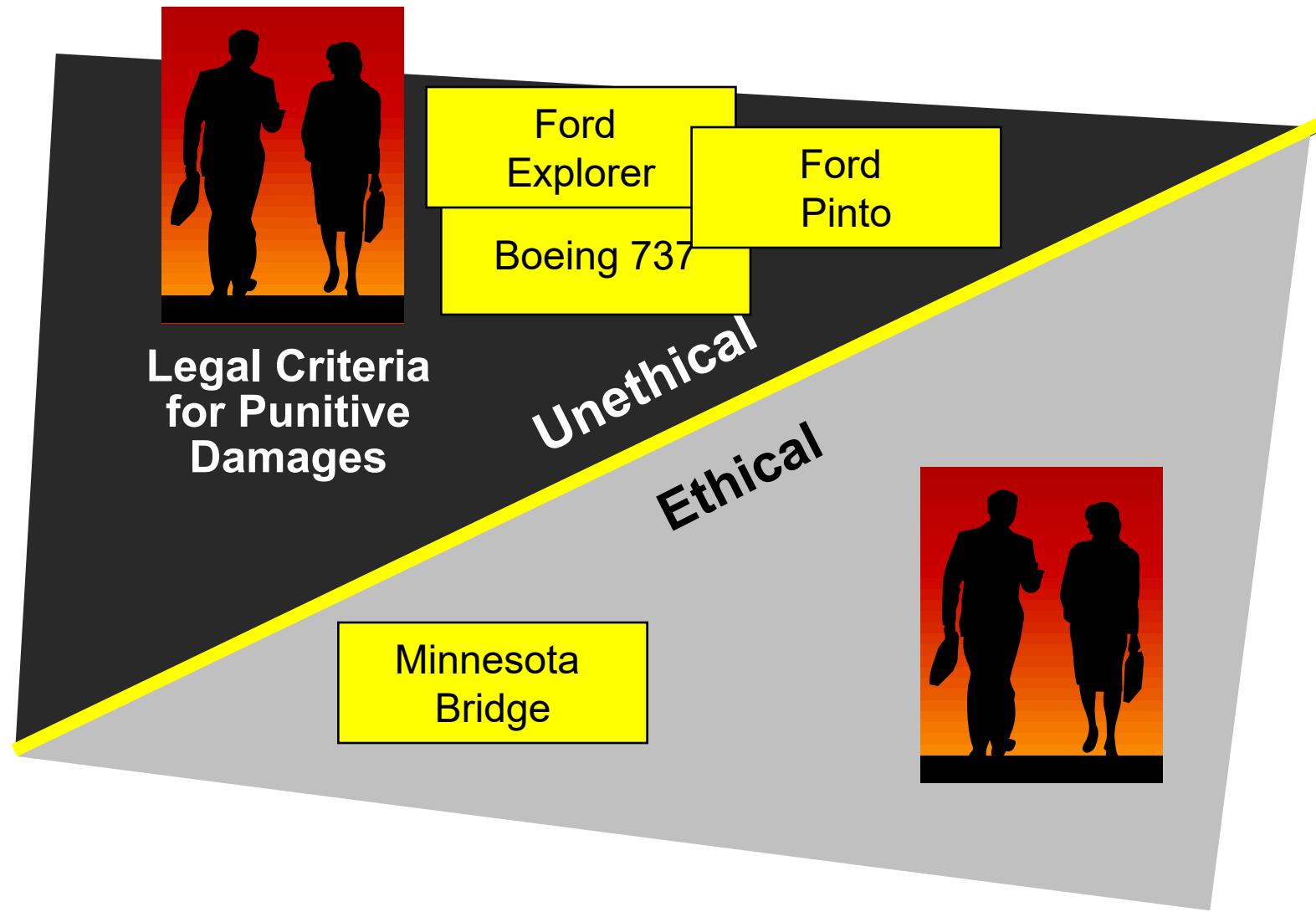
Los Angeles Times
By P.J. Huffstutter
November 14, 2008

"Federal investigators on Thursday placed the blame for last year's deadly Minnesota bridge collapse on engineering design flaws that led steel plates to buckle under the weight of construction equipment and supplies, rather than on corrosion or a lack of upkeep."



Photo © Poppyseed Bandits on Flickr

The Bright Line Concept



But Examining the Bridge Failure More Closely



Gusset Plate Miscalculation Overlooked:

- Original design would have failed critical *demand-to-capacity* calculation
- Engineering firm did not check and double check blueprints and calculations
- A failure of essential engineering duty

Upgrades Not Accounted For:

- Repaving, new curbs, anti-icing system adds 4 million pounds to bridge weight
- Plans not rechecked by consulting firm or Minnesota Dept. of Transportation
- Another failure of engineering duty

Dr. Browne: “At what point do ***multiple acts of incompetence*** become unethical?”

More Criteria: Suppression & Misdirection

Japan Nuclear Meltdown



TOKYO (AP) – Plant design engineers and regulators suppressed data that showed tsunami heights could be greater than being designed for.

And just hours after a tsunami swept into the Fukushima nuclear power plant, Japan's leaders knew the damage was so severe that much radioactivity could be spread locally, but they kept this secret for months.

Tsunami backup generators are placed on wrongly located site and are flooded, causing cooling system failure, reactor melt down and widespread contamination

More Criteria: Negligence & Procrastination



ELAINE THOMPSON Associated Press

3 KILLED IN AMTRAK DERAILMENT

The Amtrak Cascades Train 501 out of Seattle jumped the tracks near a bridge over Interstate 5 in DuPont, Wash., during an inaugural trip. Some of its cars plunged into traffic. "I was sleeping," one rider said. "Then I was flying through the air." **NATION, A5**

Designers had to be aware of Automatic Train Stop (ATS) systems that would have stopped the train, but did not choose to install such a system on this line.

More Criteria: Negligence & Procrastination



PETER DASILVA EPA/Shutterstock

ABANDONED CARS block Skyway, the main road in and out of Paradise, Calif., on Nov. 8, the first day of the Camp fire. People trying to flee got stuck in traffic.

Paradise narrowed main road despite warnings of gridlock

Paradise city council was told about the potential problem of population exit in case of fire, but voted to keep the one exit road narrow to promote downtown business.

Florida Surfside Condos: A New Case



On June 24, 2021 Champlain Towers South, a 12-story beachfront condominium in the Miami suburb of Surfside, Florida, partially collapsed.

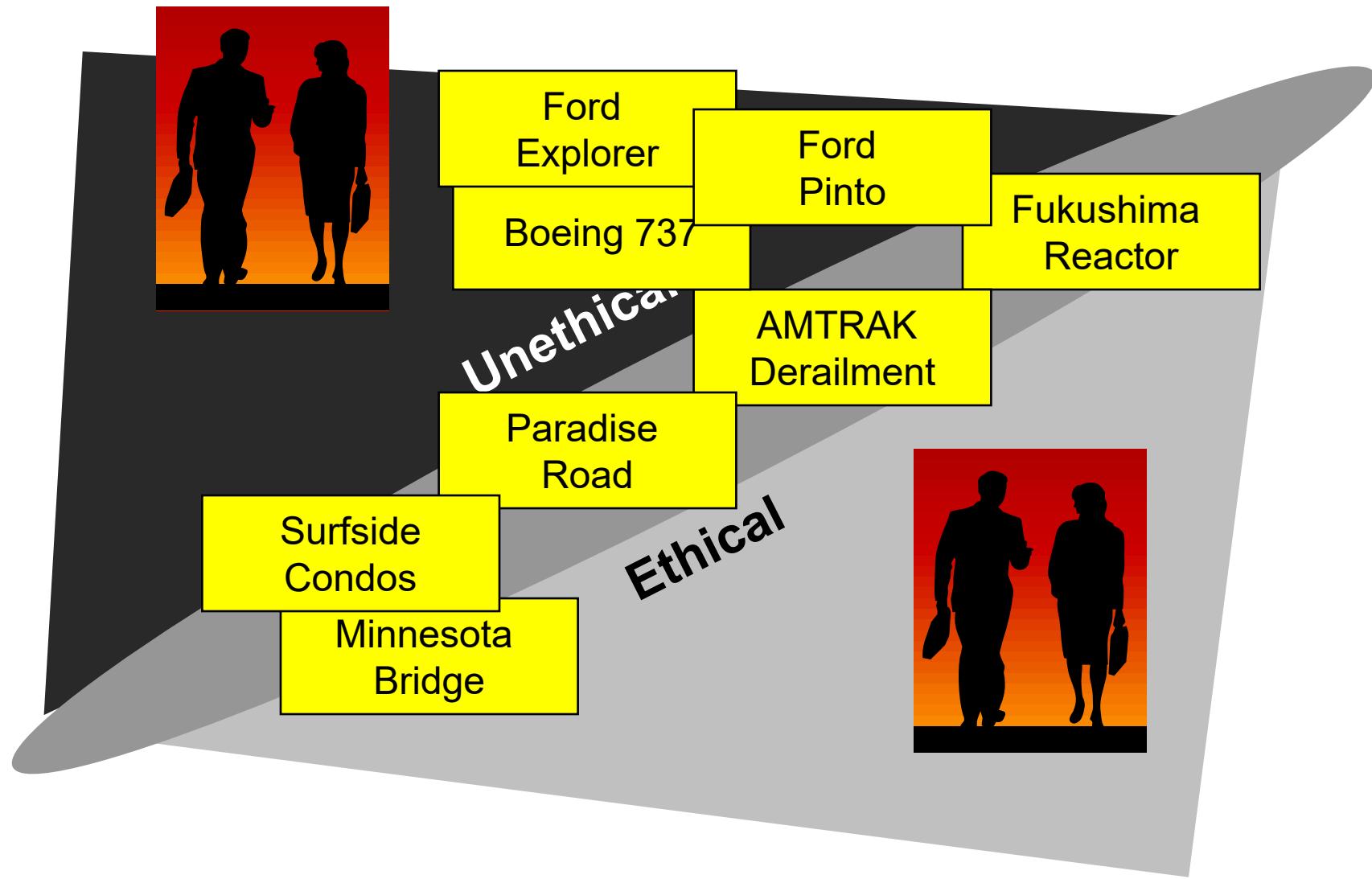
Surfside Condos: Under Investigation



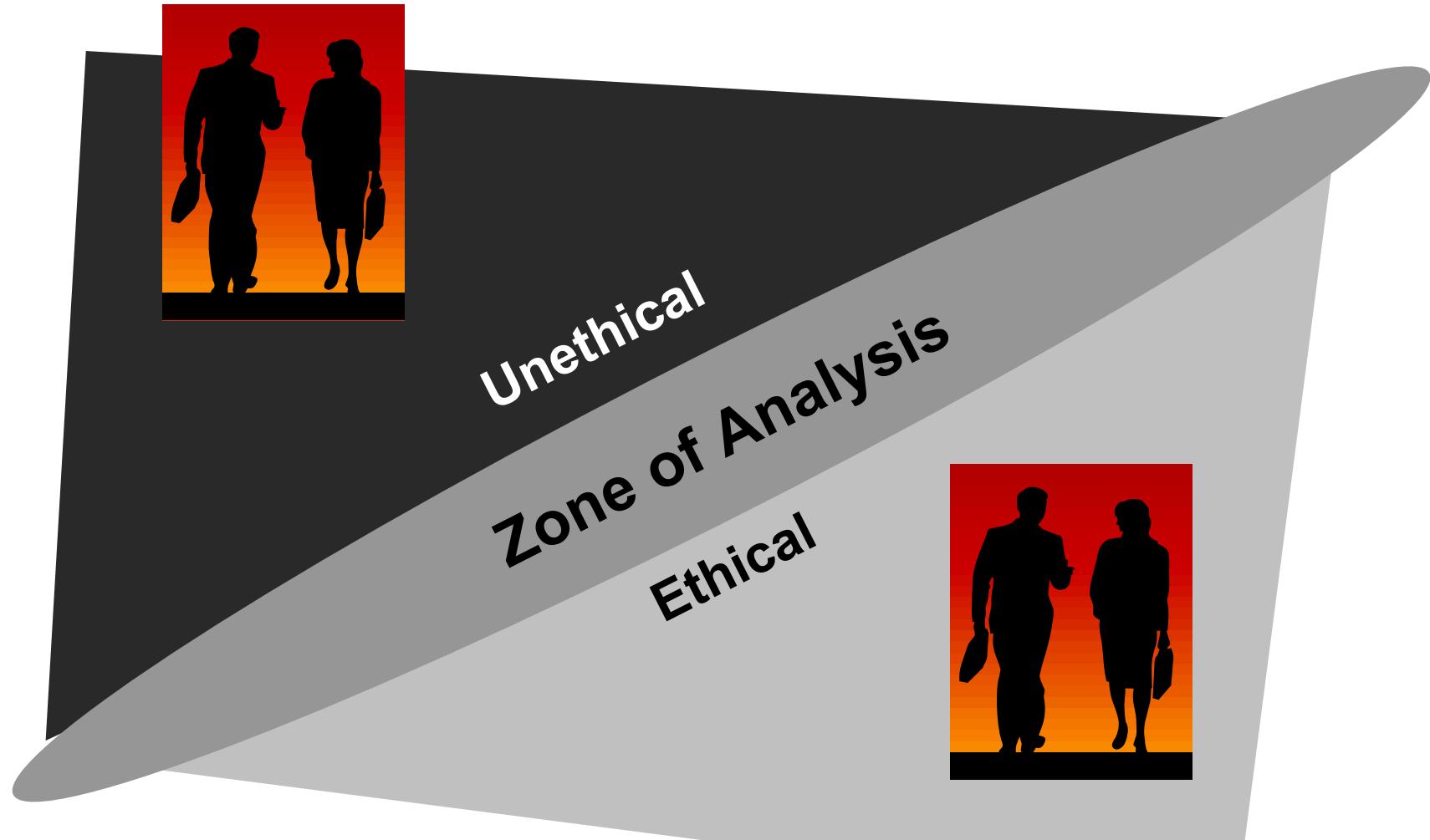
"Nothing like this was foreseeable," said Kenneth Direktor, an attorney for the condominium association. "At least it wasn't seen by the engineers who were looking at the building from a structural perspective." But a \$15M repair was being considered.



Bright Line Reexamined



Bright Line Reexamined



As in Pragmatic Ethics, project ethical analysis is a **case-by-case** undertaking.