Electrostatic Risk

Decisions Under Uncertainty

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Presentation Outline

1. Introduction
2. The Monty Hall Problem
3. Basic Risk Assessment
4. Risk Segmentation
5. Conclusion

1. Introduction

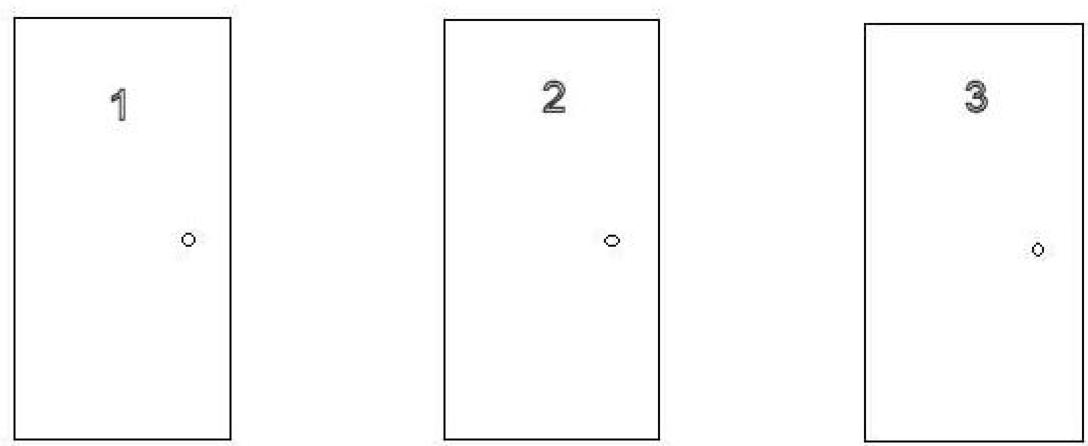
- *It has been estimated that $84 billion per year goes to corporate costs associated with ESD*.*
- *It has been estimated that average product loss to ESD is 8-33%*.*
- *Why are corporations absorbing this amount of continual risk?*

**source ESDA*

Introduction

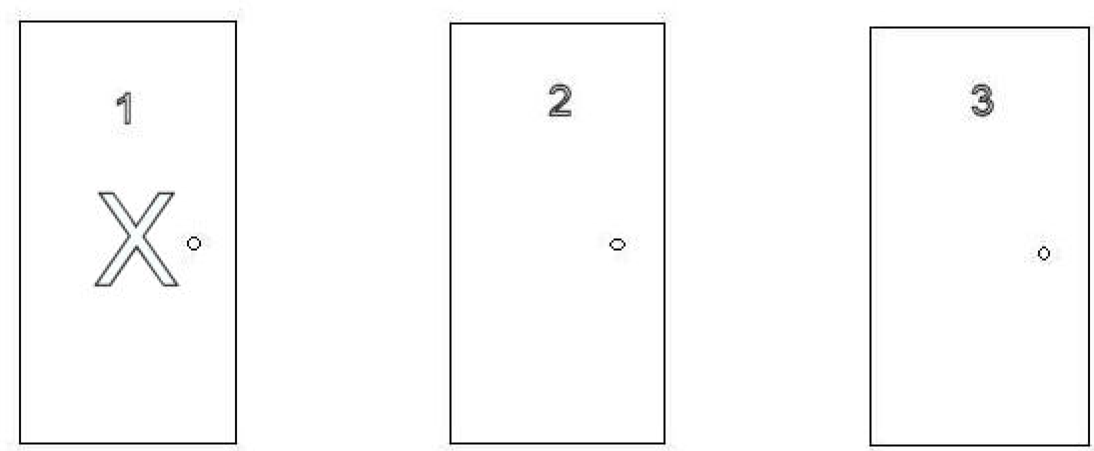
- *Utility theory has an extensive literature on how humans make decisions about gain and loss differently.*
- *Everyone makes decisions based upon informal probability assessments every day for almost every activity.*
- *Unfortunately, critical decisions are often dealt with informally as well.*
- *In addition, many decisions are subject to competition for resources or just plain inattention.*

2. The Monty Hall Problem



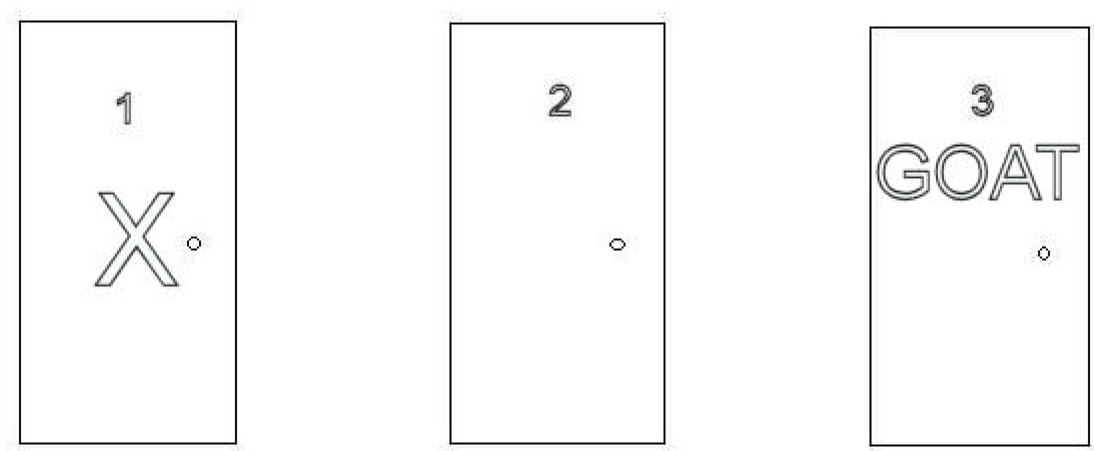
Brand new car or brand new goat?

Decision Time



Let’s say you choose Door #1…

More Decisions…



Monty shows a goat behind door #3 and asks if you would like to choose again…?

And the winner is…

If you chose again, you probably chose correctly!

When you *initially* chose door #1, you had a 1/3 chance of guessing correctly and a 2/3 chance of guessing incorrectly.

By choosing again, the odds are in your favor *granting that you probably chose wrongly to start with.*

3. Basic Risk Assessment

- *Formal risk is usually defined as the probability of an event or condition and the expected consequences:*

  $R_{isk} = P_{robability}\ x\ C_{onsequences}$ $\quad$ $T_{otal}R_{isk} = \text{sum of } R_{isks}$

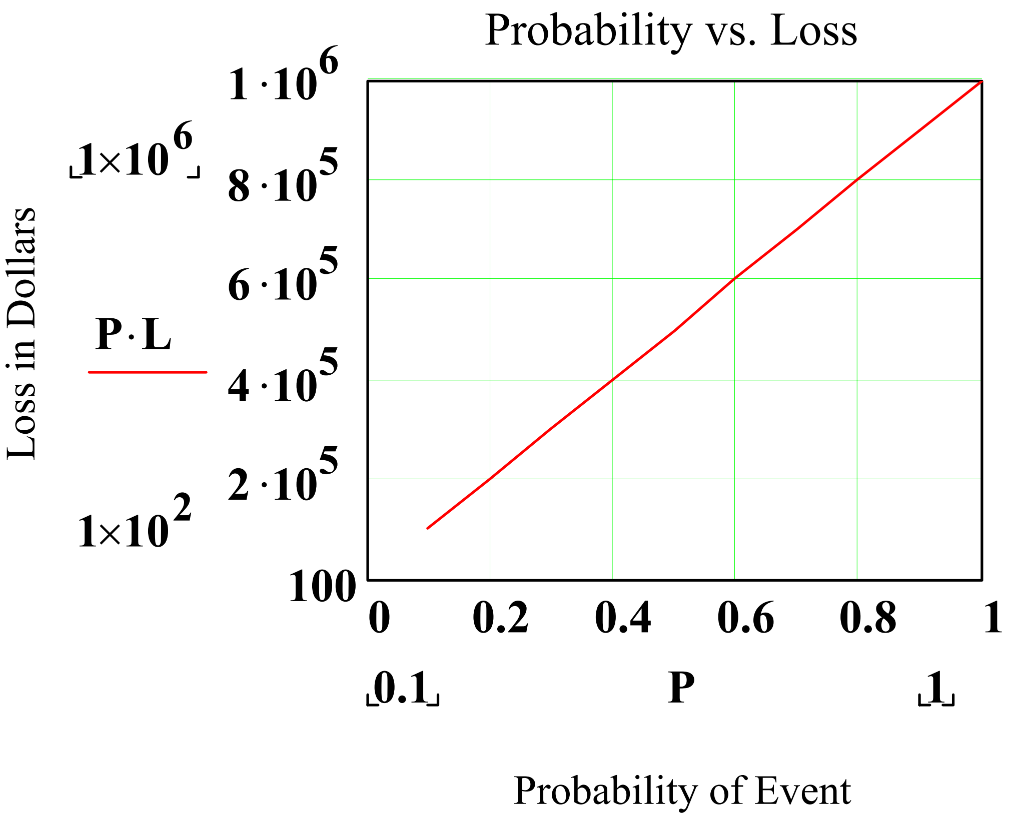
- *Typically, expected consequences are characterized as functions of gain or loss.*

- *The basic mathematics is fairly straightforward.*

- *However, the determination of event probability and consequence values can be quite challenging.*

Basic Risk

Risk = Prob x Loss



Determining Probabilities

- *Probability of electrostatic problems in your manufacturing process?*

    - addressed with an ESC program, yield data, FA…

- *Probability that defective product is being shipped?*

    - addressed with inspection/quality control programs

- *Probability that defective product will cause significant after-manufacturing losses, etc.?*

    - varies by product type and customer expectation

Gambler's Fallacy

- *People are prone to the belief that events are naturally spaced by their probability frequency.*

- *This fallacy appears in gambling as the belief that events are more or less likely to occur than they are.*

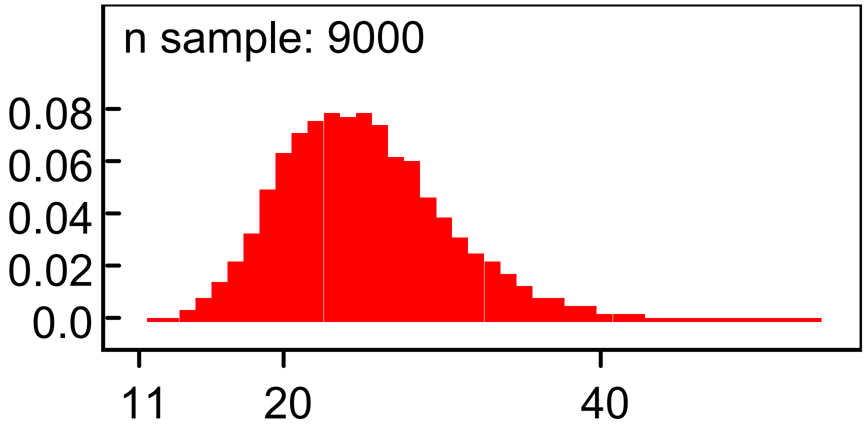
- *Example: Fair coin toss*

  It is possible to flip 9 heads in a row, even though we know that the probability is 0.5 for heads, and 0.5 for tails.

Coin Toss Probability

- *Example: How many times do you have to flip a coin to get 10 heads?*

- *A Binomial probability at 0.5 is 25 times, but with a credible interval of 18 to 34 times.*



Finding Loss Utilities

- *Calculating manufacturing loss (materials, time lost, sales, etc.)*
- *Calculate yield loss from product testing (failure rates)*
- *Estimated loss for rare events (what if scenarios)*
- *Total loss summed across all risks*

3. Risk Segmentation

Risk, and the decisions associated with it, are distributed across any organization:

- *manufacturing processes*
- *quality control (or lack thereof)*
- *management decision process*
- *sales/marketing*
- *unforeseen events*
- *unlikely events*

Manufacturing ESD Risk

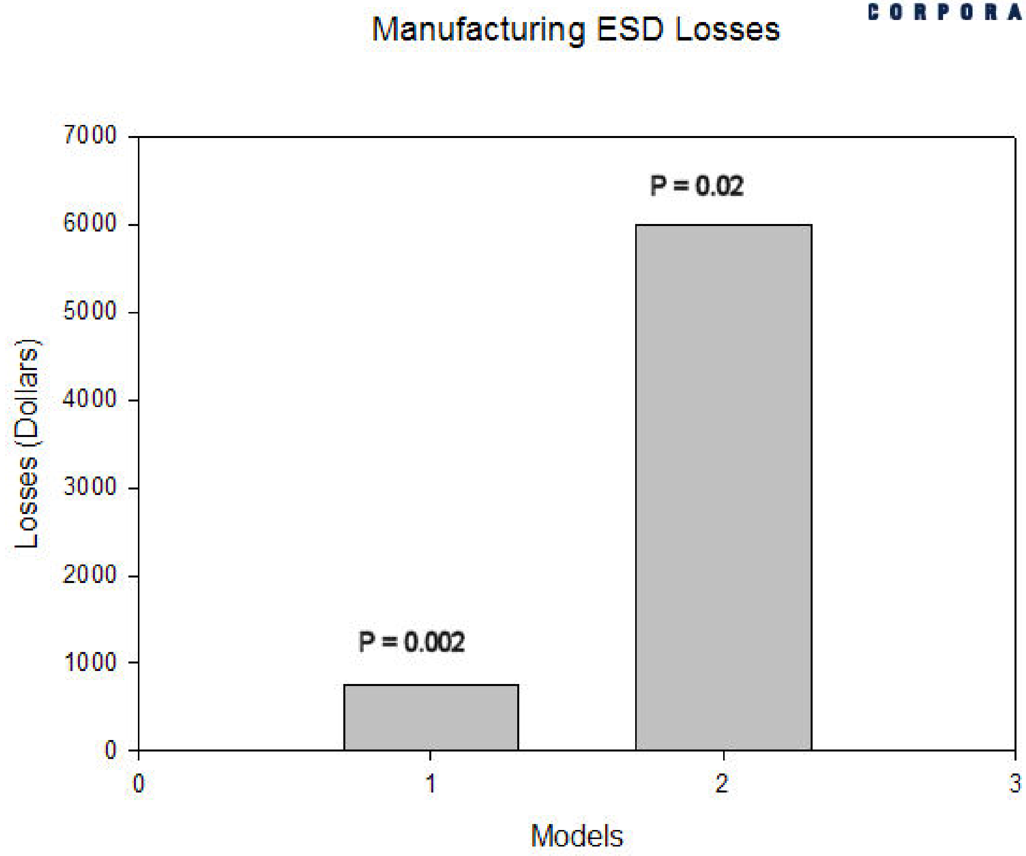
Failures:

Model 1, 25/10000

Model 2, 200/10000

Loss is $30 for all costs associated per failure.

Failure rate assumes complete testing of all devices.

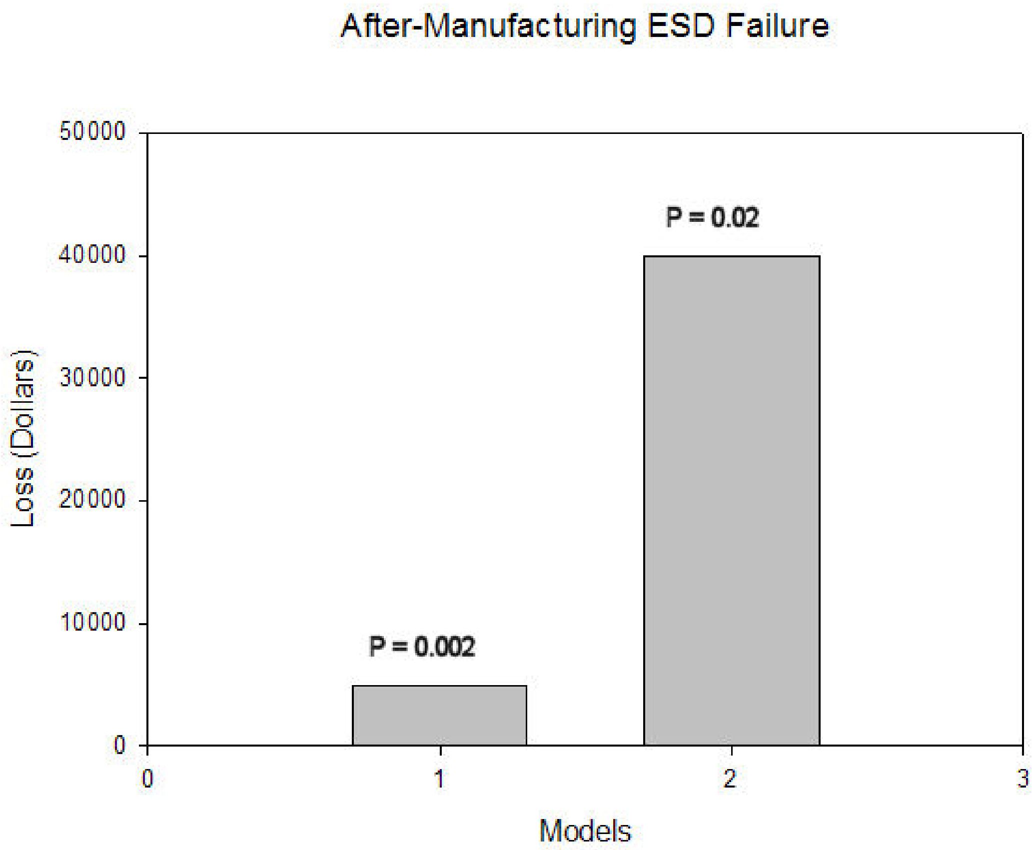


After-Manufacturing Risk

Same device failure models.

Loss is now greater and calculated at $200 per failed device.

Some products have enormous loss potential.



Decision Competition

You have $100k in your engineering budget:

1) *Do you use it to create/enhance an ESC program?*

2) *Do you use it for other projects?*

3) *You think you know your risk probabilities…*

4) *You have several estimated loss models, including a worst-case scenario…*

Decision Scenario #1

a) *You think there is a 95% chance that the money is better spent on non-ESC expenditures:*

P(0.95) x $100k = $95k Gain

b) *You think that the chance of ESD losses are <5% and would be limited to about $100k.*

P(0.05) x $100k = $5k Loss

Risk = (0.95 x 100k) + (0.05 x 100k) = $90k Gain

Decision Scenario #2

a) You think there is a 95% chance that the money is better spent on non-ESC expenditures:

P(0.95) x $100k = $95k Gain

b) You think that the chance of ESD losses are <5% and would be limited to about $4M.

P(0.05) x $10M = $200k Loss

Risk = (0.95 x 100k) + (0.05 x 4M) = $105k Loss

Catastrophic Risk

- *Most ESD risks don't make it very far into the catastrophic loss category (with several exceptions*).*
- *If you run the normal calculation for a very small probability and a very large loss, you have to be careful.*
- *Example: $100M potential loss x P(0.001) = $100K Loss*
- *These scenario-based loss estimates are actually better modeled as threshold functions. If the event happens, the full loss is expected.*

*semiconductor reticles

A Decision Hero

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Col. Stanislav Petrov, Soviet Missile Command, Moscow

September 26, 1983, 12:04pm…

At the height of the Cold War…

His decision under uncertainty and extreme stress is quite possibly the reason we are all here today.

5. Conclusion

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- *Formal risk analysis leads to better decisions.*
- *If you control the probabilities for electrostatic variables, you control the risks.*
- *Even though rare events seem distant, they do occur.*
- *The risk is yours…*

Thank you.