國立臺北大學自然資源與環境管理研究所
102 學年度第二學期『環境災害與風險管理』

課程講義（12）：危害分析、系統可靠度與模擬工具軟體
Hazard Analysis, Systems Reliability and Simulation Software

http://www.ipedr.com/vol11/16-R10014.pdf
Critical Review of a Risk Assessment Method and its Applications
http://www.weibull.com/basics/
Reliability Analysis Quick Subject Guides
http://www.ihs.com/info/ehss/dyadem-stature-pha-pro.aspx
EHS & Sustainability Software from HIS
Monte Carlo Simulation Software:
Oracle Crystal Ball, @Risk, ModelRisk, GoldSim, etc.

- INTRODUCTION
  - Risk Assessment Steps
    - ⇨ Identification of hazards likely to result in disasters: What hazardous events may occur?
    - ⇨ Estimation of the risks of such events: What is the probability of each event?
    - ⇨ Evaluation of the consequences of the derived risk: What is the likely loss created by each event?
  - Types of Risk Analysis (Molak, 1997)
    - ⇨ Noncancer chemicals risk analysis and Carcinogen risk analysis
    - ⇨ Epidemiological risk analysis
    - ⇨ Probabilistic risk analysis associated with plant safety
    - ⇨ A posteriori risk analysis
    - ⇨ Nonquantitative risk analysis, or “common sense” risk analysis
  - Risk Analysis Techniques related to Safety or Reliability (Dhillon, 2003)
    - ⇨ Fault Tree Analysis
    - ⇨ Failure Modes and Effect Analysis (FMEA)
    - ⇨ Failure Mode Effects and Criticality Analysis (FMECA)
    - ⇨ Hazard and Operability Analysis (HAZOP)
  - Risk Analysis Methodologies: Qualitative Methodologies

- FAULT TREE ANALYSIS (FTA)
  - Event Tree, Decision Tree, and Fault Tree
  - Safety, Reliability, Risk, and Industrial Hazards
  - Components: Result, Gates (and/or), Fault Events (input/output)
  - Examples; Advantages/Disadvantages

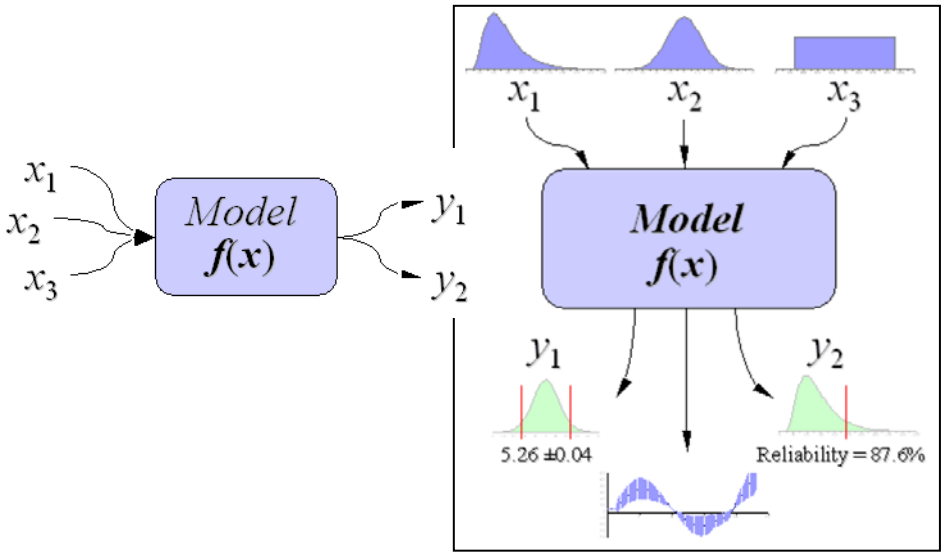
- FMEA, FMECA AND HAZOP
  - An Overview of FMEA and FMECA (http://www.weibull.com/basics/fmea.htm)
  - FMEA Info Centre (http://www.fmeainfocentre.com)
  - Failure Modes and Effect Analysis (FMEA) 失效模式與效應分析
  - Failure Mode Effects and Criticality Analysis (FMECA) 失效模式效應與關鍵性分析
  - Hazard and Operability Analysis (HAZOP) 危害及可操作性分析
    (http://158.132.155.107/posh97/private/accident-prevention/HAZOP_Technique.pdf)

- RISK ANALYSIS SOFTWARE
  - Statistics and Probability: Calculation, Fitting, and Visualization
  - Event Tree, Value Tree, Fault Tree, and Decision Tree => (PrecisionTree)
  - Reliability and Safety => Fault and Failure
    - ⇨ Fault Tree Analysis, FMEA, and FMECA
    - ⇨ Risk Priority Numbers (RPN) for Failures: Severity, Occurrence & Detectability
  - Process and Operation => Hazard and Operability
    - ⇨ Process Hazards Analysis: HazOp, Job Safety Analysis, etc.
    - ⇨ Brainstorming, Countermeasures, and Cost Assessment

- SOFTWARE PACKAGES FOR RISK (RELIABILITY) ANALYSIS
  - EHS & Sustainability Software from HIS (formerly Dyadem Software)
    - ⇨ FMEA-Pro Failure Modes and Effects Analysis
    - ⇨ PHA-Pro Process Hazards and Analysis: HazOp, What If, Checklist, FMEA & PrHA
  - Palisade Corporation: The DecisionTools Suite
    - ⇨ @RISK, PrecisionTree, TopRank, RISKOptimizer
    - ⇨ Examples for Applying DecisionTools: Volcano Eruption

- QUANTITATIVE RISK ANALYSIS: SIMULATION
  - Representation of Uncertainty => Simulation
    - ⇨ Decision Making under Uncertainty (Risk)
    - ⇨ Simulation or Optimization? Simulation/Optimization (?)
  - Monte Carlo Simulation

    Step 1: Create a parametric model, $y = f(x_1, x_2, \cdots, x_q)$.
    Step 2: Generate a set of random inputs, $x_1^i, x_2^i, \cdots, x_q^i$.
    Step 3: Evaluate the model and store the results as y^i .
    Step 4: Repeat steps 2 and 3 for $i = 1 \cdots n$.
    Step 5: Analyze the results using histograms, statistics, confidence intervals, etc.



(http://www.vertex42.com/ExcelArticles/mc/MonteCarloSimulation.html)

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
Front Door L.H.

System: 1 - Automobile
Subsystem: 2 - Closures
X Component: 3 - Front Door L.H.
Model Year(s)/Vehicle(s): 199X/Lion 4dr/Wagon
Core Team: A. Tate Body Engrg, J. Smith - QC, R. James - Production, J. Jones - Maintenance

Process Responsibility: Body Engineering
Key Date: 3/31/2003

FMEA Number: 1450
Page 1 of 1
Prepared By: J. Ford - X6521 - Assy Ops
FMEA Date (Orig.): 3/10/2003 (Rev): 3/21/2003

Item / Process Function/Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/Mechanism(s) of Failure	Occur	Current Process Controls Prevention	Current Process Controls Detection	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	Sev	Occ	Det	RPN
3 - Front Door L.H.																	
Manual application of wax inside door. To cover inner door, lower surfaces at minimum wax thickness to retard corrosion.	Insufficient wax coverage over specified surface.	Deteriorated life of door leading to: - Unsatisfactory appearance due to rust through paint over time. - Impaired function of interior door hardware.	7		Manually inserted spray head not inserted far enough.	8		Visual check each hour - 1/shift for film thickness (depth meter) and coverage.	5	280	Add positive depth stop to sprayer.		Stop added, sprayer checked on line.	7	2	5	70
					Spray head clogged - Viscosity too high - Temperature too low - Pressure too low.	5		Test spray pattern at start-up and after idle periods, and preventive maintenance program to clean heads.	3	105				7	1	3	21
					Spray head deformed due to impact.	2		Preventive maintenance program to maintain heads.	2	28				7	2	2	28
					Spray time insufficient.	8		Operator instructions and lot sampling (10 doors/shift) to check for coverage of critical areas.	7	392				7	1	7	49

- **Risk Priority Numbers: RPN = Severity × Occurrence × Detection**
- **Criticality Analysis**

  Mode Criticality = Expected Failures × Mode Ratio of Unreliability × Probability of Loss

  Item Criticality = SUM of Mode Criticalities