M'sila University, Department of Computer Science, Master1 AI

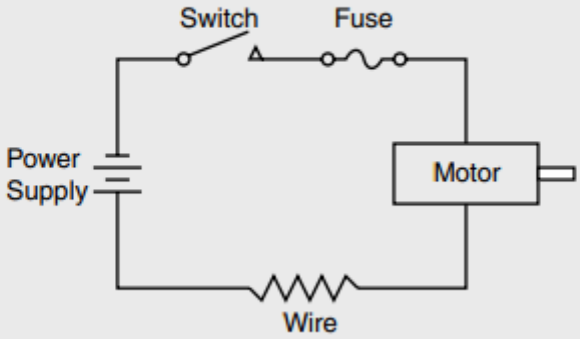
COURSE: Diagnostic Methods **DR. R. BENTRCIA**

TD 2: Fault Tree Analysis

From: M. Pandey, University of Waterloo. CIVE 240 – Engineering and Sustainable Development. Fault Tree Analysis.

Exercise 1:

Example: (*McCormick*, 1981) Construct a fault tree for the simple electric motor circuit shown below.



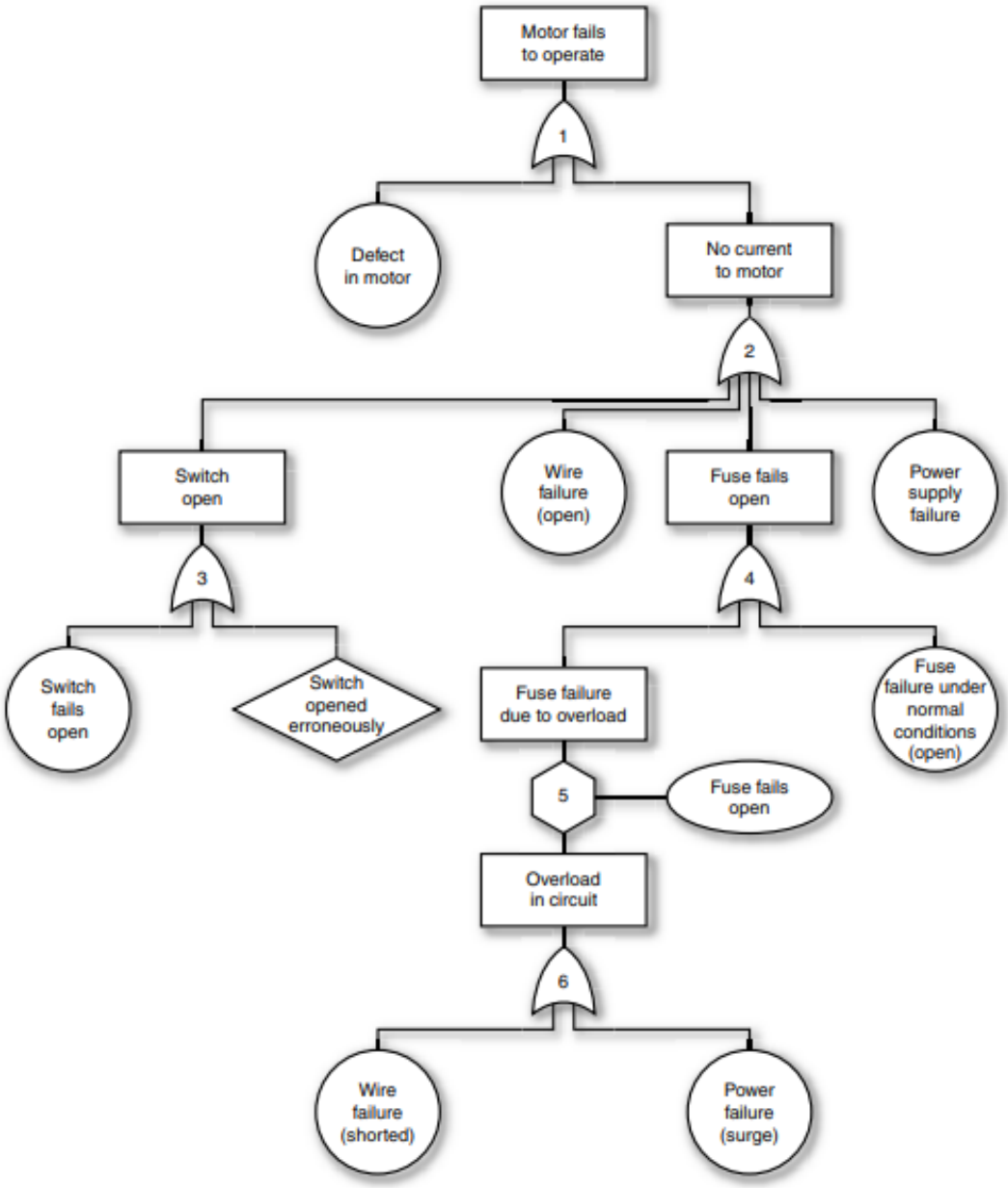
1. Define the system of interest
2. Define the top event
3. Construct the fault tree, starting from the top, i.e., define the treetop structure. Identify the main contributing events, including all events and scenarios that may cause the top event.
4. Analyse the constructed fault tree: qualitative analysis

Exercise 2:

Example: Calculate the probability of occurrence of the top event for the simple motor example. Assume the probability of occurrence of each basic event is equal to 0.01 and the probability of the event S1 "Switch opened erroneously" is equal to 0.001. Also assume that the condition C1 "Fuse fails open" has a probability of occurrence of 0.50.

Solution

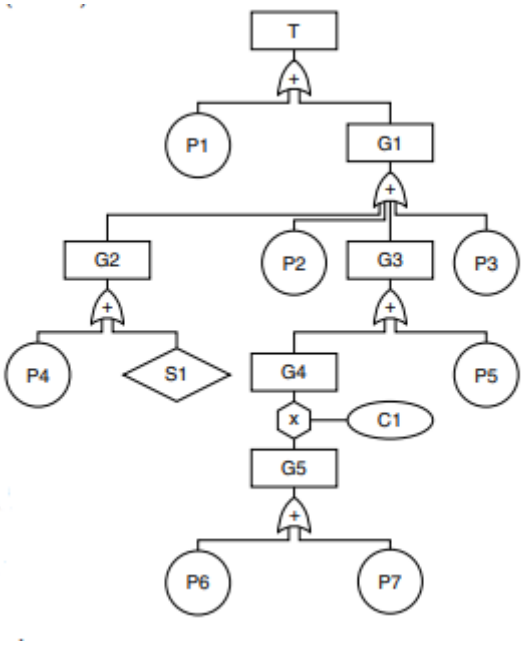
1. Intended Function – the motor is used for some (unknown) purpose
2. We are interested in the event that the motor fails to operate.
3. The fault tree



4. The qualitative analysis

Conducted using minimal cut sets:

- Let T denote the top event
- Let P denote primary events (circles)
- Let G denote intermediate events (rectangles)
- Let S denote undeveloped events (diamonds)
- Let C denote conditioning events (ovals)



Therefore

T = motor fails to operate

P1 = defect in motor

P2 = wire failure (open)

P3 = power supply failure

P4 = switch fails open

P5 = fuse failure under normal conditions (open)

P6 = wire failure (shorted)

P7 = power failure (surge)

G1 = no current to motor

G2 = fuse fails open

G3 = switch open

G4 = fuse failure due to overload

G5 = overload in circuit

S1 = switch opened erroneously

C1 = fuse fails to open

Writing equations for each gate of the tree

T = P1 + G1

G1 = P2 + P3 + G2 + G3

G2 = P4 + S1

G3 = G4 + P5

G4 = C1 · G5

G5 = P6 + P7

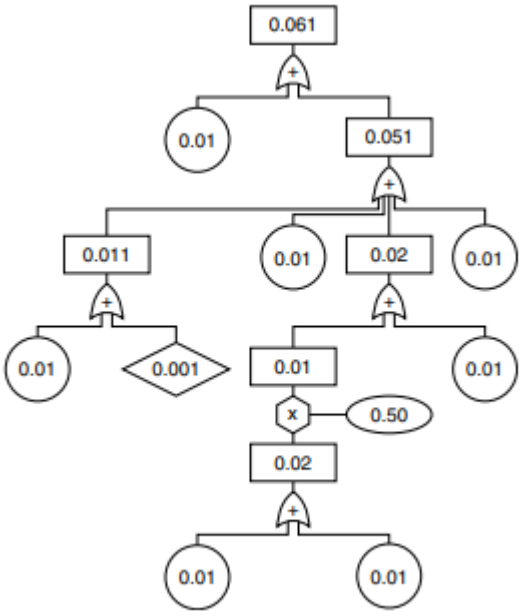
Using the top-down approach we get by substitution

T = P1 + P2 + P3 + P4 + S1 + P5 + (C1 · P6) + (C1 · P7)

The top event, therefore, contains 6 single component minimum cut sets and 2 double component minimum cut sets.

5. Quantitative Analysis

Event	Description	Probability
P1	Defect in motor	0.01
P2	Wire failure (open)	0.01
P3	Power supply failure	0.01
P4	Switch fails open	0.01
P5	Fuse failure under normal conditions (open)	0.01
P6	Wire failure (shorted)	0.01
P7	Power failure (surge)	0.01
S1	Switch opened erroneously	0.001
C1	Fuse fails open	0.50



The probability of intermediate events can be evaluated using the fault tree.

The probability of the top event is given by the union of the minimum cut sets determined before as T = P1 + P2 + P3 + P4 + S1 + P5 + (C1 · P6) + (C1 · P7)

= 0.01 + 0.01 + 0.01 + 0.01 + 0.001 + 0.01 + (0.50)(0.01) + (0.50)(0.01) = 0.061