IOWA STATE UNIVERSITY

Industrial and Manufacturing Systems Engineering

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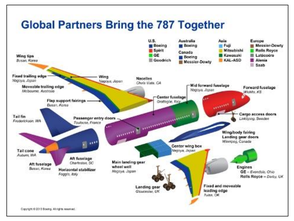
Supply Chain Risk Analysis Using Dynamic Fault Tree

1. Research goals

- Assess the risk of failure in a supply chain
- Use a dynamic fault to quantify the risk
- Consider different production scenarios

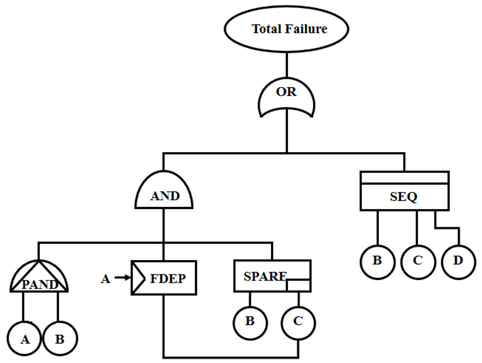
Low value high volume supply chain



High value low volume supply chain

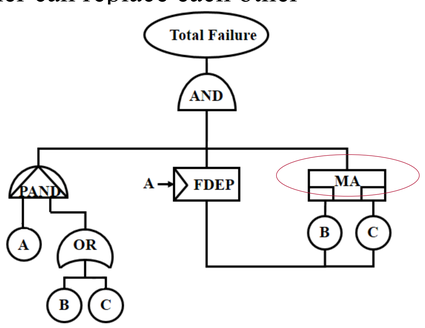
2. Dynamic fault tree for supply chains

- Main-backup supply chain: 1 supplier and 1 backup



Note: A=information system's failure; B= main supplier's failure; C=backup supplier's failure; D=inventory's failure

- Mutual-assistance supply chain: 2 active suppliers and either can replace each other



Note: A=information system's failure; B= one supplier's failure; C= the other one supplier's failure

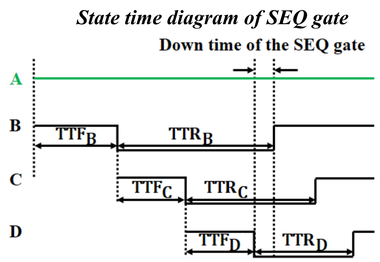
3. Illustrative examples

Main-backup supply chain

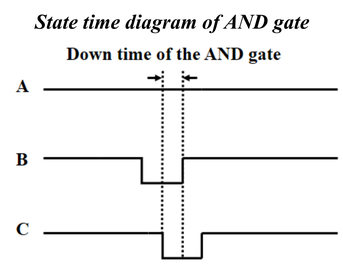
Scenario 1: One unit of product
- Failure rate
- Overall delivery time

→ State-time diagram

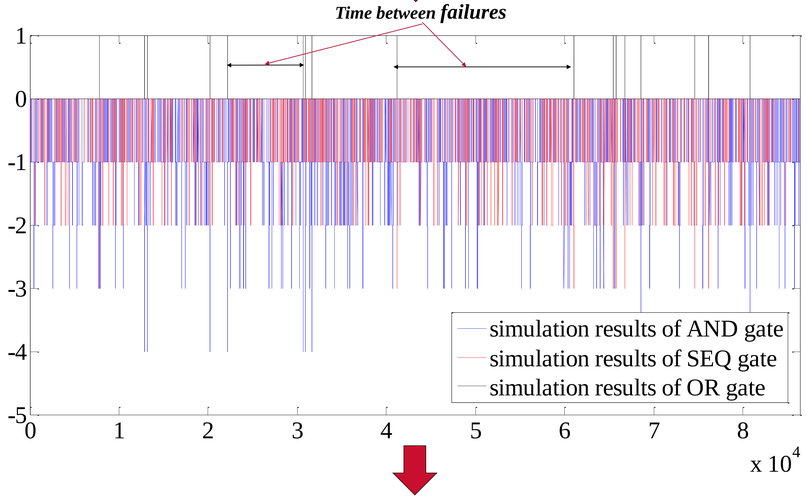
State time diagram of SEQ gate



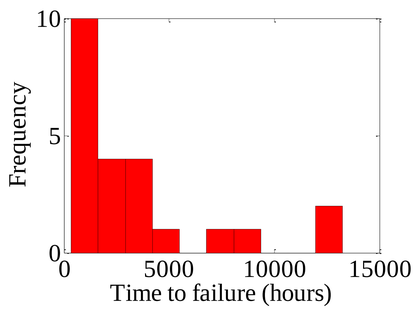
State time diagram of AND gate



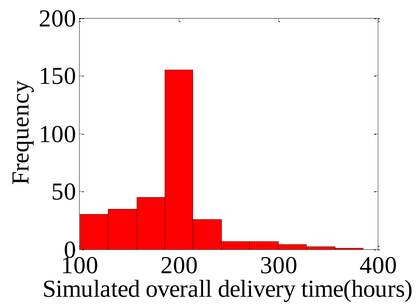
Time between failures



Histogram of Simulated Time to Failure



Histogram of Simulated Overall Delivery Time



The mean time to failure of the main-backup supply chain is 3401 hours which is 142 days.
The mean actual overall delivery time is 189 hours which is 8 days.

Scenario 2: Several units of product
- Total units of product

→ Customized simulation method

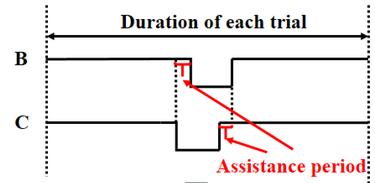
Mutual-assistance supply chain

Scenario 1: One unit of product
- Overall delivery time
- Failure rate

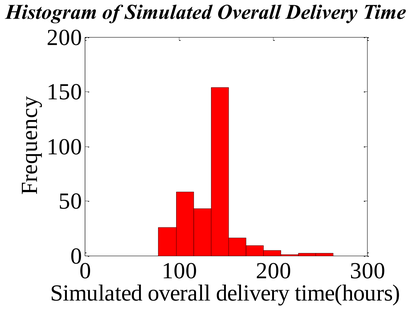
→ State-time diagram

Scenario 2: Several units of product
- Total units of product

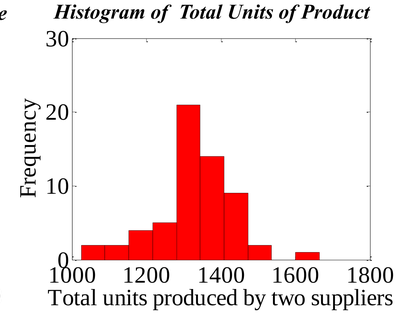
State time diagram of a trial in mutual-assistance supply chain



Histogram of Simulated Overall Delivery Time



Histogram of Total Units of Product



The mean actual overall delivery time is 143 hours which is 6 days.
The mean of total units produced by two suppliers is 1331.

4. Contributions

- Dynamic fault tree provides ability to model sequence of failures within a supply chain
- An innovative dynamic gate, the mutual-assistance gate, is created.
- Calculate both failure rate and delivery time
- Two different production scenarios, low volume production and high volume production, are considered.

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