Chapter 3
Cause-Effect Diagrams

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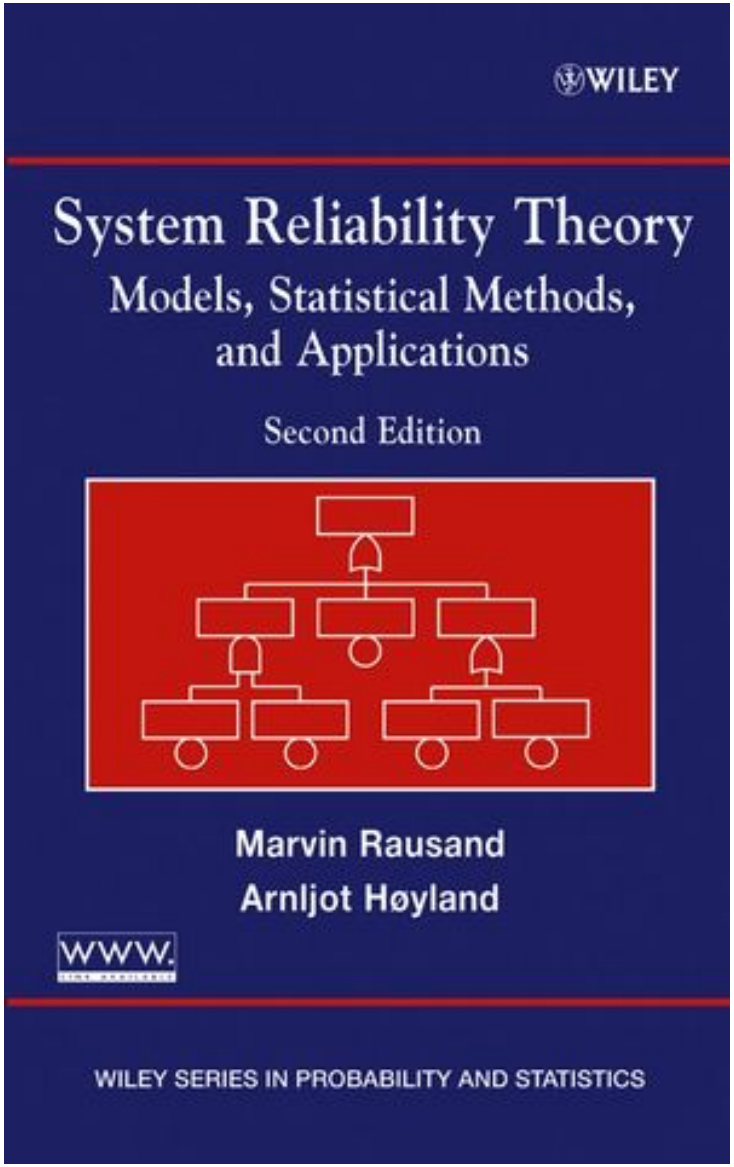
Slides related to the book

System Reliability Theory
Models, Statistical Methods, and Applications

Wiley, 2004

Homepage of the book:
http://www.ntnu.edu/ross/books/srt



What is a cause-effect diagram?

- A tool to identify, explore, and graphically display – in increasing detail – all the possible causes related to a specified problem
- The cause-effect diagram is established by a team of analysts
- The analysis is based on brainstorming
- Created by Professor *Kaoru Ishikawa*, Tokyo University in 1943
- Adopted by W. Edwards Deming
- Also known as Ishikawa or Fishbone diagrams
- A cause-effect diagram is not a quantitative tool

Why use cause-effect diagrams?

In the context of this book, a cause-effect diagram may be used:

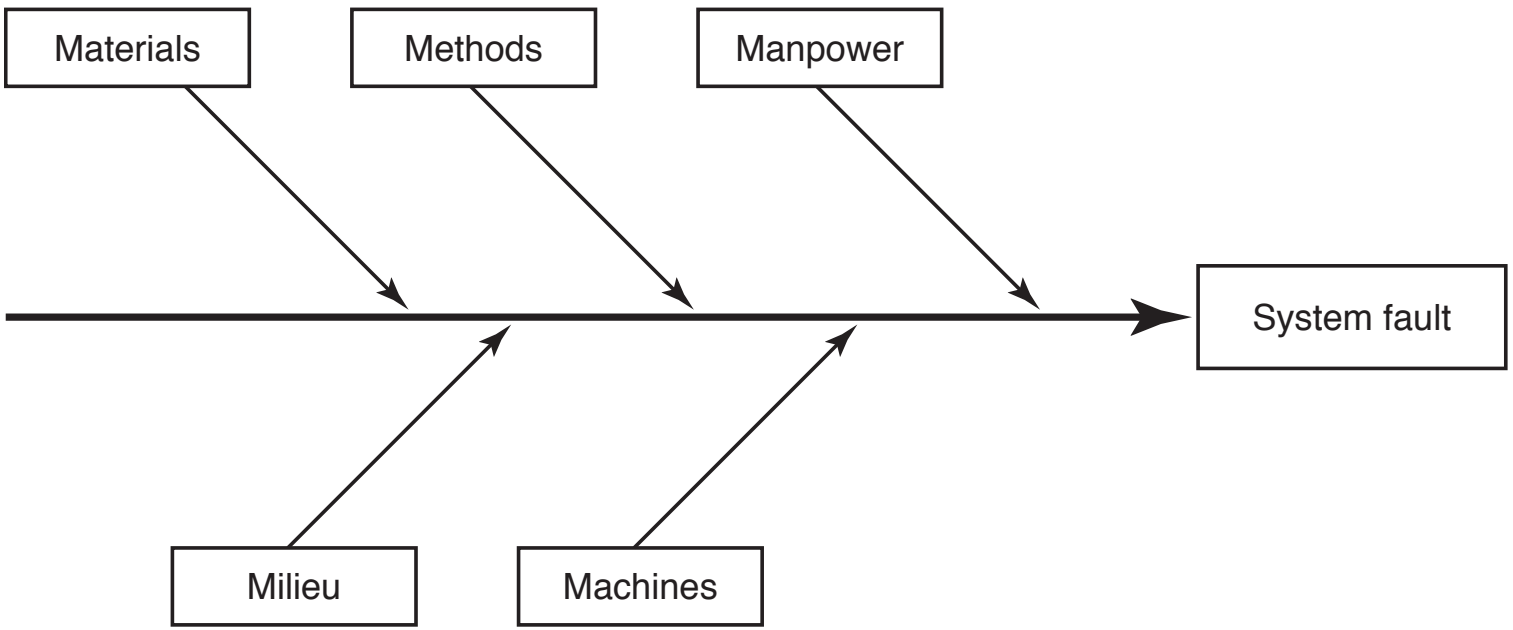
- To identify all the possible causes of a (system or subsystem) fault
- To display the relationship between the causes and the fault
- To suggest solutions to the problems

Step 1

Identify, describe, and delimit the main problem (e.g., a system fault). Briefly describe the problem in a box at the right-hand side of a page, draw a long arrow across the page pointing at the box. The arrow is sometimes referred to as the spine of the (fishbone) diagram

Step 2

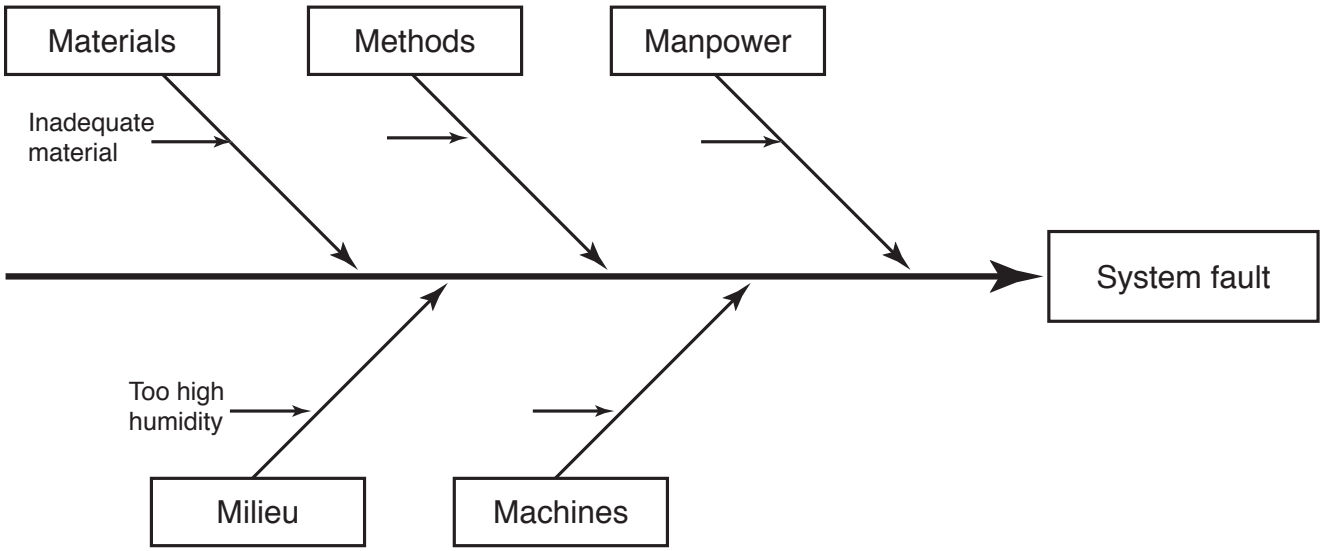
Agree on 4-7 main *categories* of causes (e.g., manpower, methods, materials, machinery, milieu). Draw arrows pointing at the main arrow (spine), and write a category of causes in a box at the end of each arrow.



Step 3

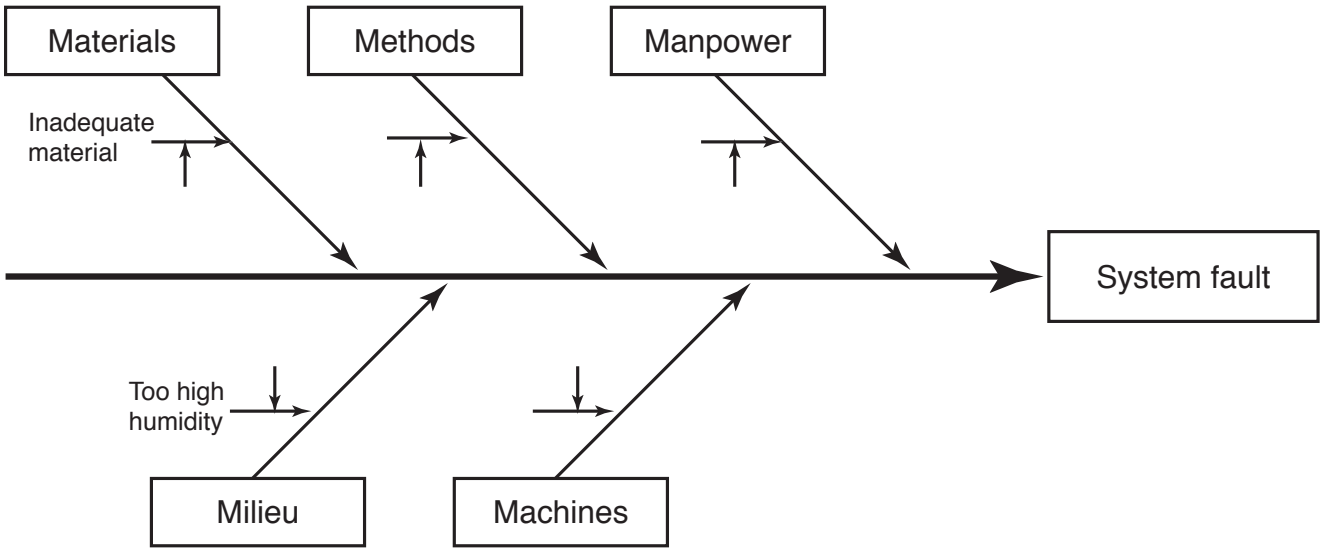
For each category (e.g., Materials), identify *factors* that may contribute to the main problem.

- Factors are identified by repeatedly asking: "Which *factors* may contribute within this category?"
- Carefully define and delimit each factor.
- Draw arrows pointing at the category's arrow and enter the factors identified



Step 4

For each factor (e.g., Too high humidity), identify sub-factors (i.e., causes) that may contribute to the factor. Define and delimit the sub-factors and draw arrows pointing to the arrow from the factor.



Continue the identification of sub-factors and sub-sub-factors until the desired level of resolution is reached.

Step 4 – Example

Assume that we are analyzing an automobile that has crashed and identified the factor "Brake failure". This factor may be further analyzed by asking the following questions:

Question	Possible answer
Why did the brakes fail?	Brake pads were worn
Why were the brake pads worn?	They were not checked
Why were they not checked?	The automobile was not properly serviced
Why was the automobile not properly serviced?	The importance of regular servicing was not realized

Step 5

Analyze the obtained cause-effect diagram.

- Check the logic and the completeness of the diagram
- Look for causes that appear repeatedly
- Look for what you can measure in each cause so you can quantify the effects of the changes you make
- Identify and circle the causes you can take action on

Step 6

Prioritize and plan actions.

- Decide which of the cause-effect chains that are the most likely causes of the problem (e.g., system fault)
- Identify actions needed to remove the causes or reduce the likelihood of the problem
- Decide on
  - What to do?
  - Who is going to do it – or be responsible?
  - When should it be done?

Categories of causes - 1

Categories for Step 2 used in the *manufacturing* industry are:

- Machine (technology)
- Method (process)
- Material (incl. raw materials, consumables, information)
- Manpower (physical work) and Mindpower (brainwork)
- Measurement (inspection)
- Milieu (the environment)

Two additional categories are sometimes added:

- Management / Money power
- Maintenance

Categories of causes - 2

Categories for Step 2 used in the *service* industry are:

- Surroundings
- Suppliers
- Systems
- Skills
- Safety

Benefits

- It generates a structured list of possible causes of the specified problem (e.g., a system fault)
- The graphical form of the diagram helps to present the results to others
- The causes can be prioritized
- It encourages group participation and makes use of group knowledge
- It uses an orderly, easy-to-read format to show the cause-effect relationships
- It increases the system knowledge and helps the participants learn more about factors influencing the system performance
- It identifies areas where data should be collected for further study