# BEA's Analysis Methodology

ICAO Accident/Incident Investigation Workshop
Oficina Regional NACC de la OACI – Mexico City
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The Analysis

Factual Information → Analysis → Conclusion (causes & contributing factors) → Safety Recs
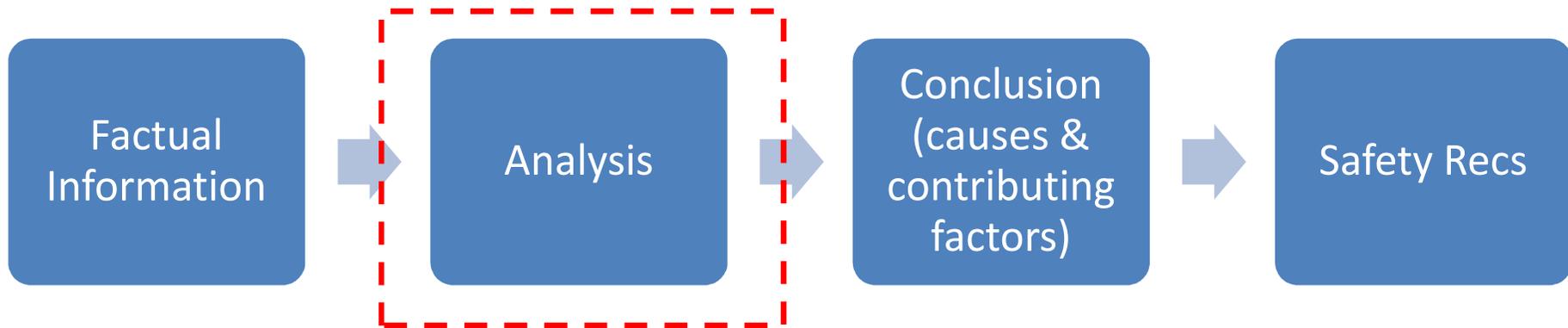
You have the facts…

- 1 - Factual Information
  - ➡ 1.1 History of the flight
  - ➡ 1.2 Injuries to persons
  - ➡ 1.3 Damage to aircraft
  - ➡ 1.4 Other damage
  - ➡ 1.5 Personnel information
  - ➡ 1.6 Aircraft information
  - ➡ 1.7 Meteorological information
  - ➡ 1.8 Aids to navigation
  - ➡ 1.9 Communications
  - ➡ 1.10 Aerodrome information
  - ➡ 1.11 Flight recorders
  - ➡ 1.12 Wreckage and impact information
  - ➡ 1.13 Medical and pathological information
  - ➡ 1.14 Fire
  - ➡ 1.15 Survival aspects
  - ➡ 1.16 Tests and research
  - ➡ 1.17 Organizational and management information
  - ➡ 1.18 Additional information
  - ➡ 1.19 Useful or effective investigation techniques

BEA Analysis Methodology

How to build the Analysis?

My Analysis

????????????

International Standards and Recommended Practices

Annex 13
to the Convention on International Civil Aviation

Aircraft Accident and Incident Investigation

This edition incorporates all amendments adopted by the Council prior to 23 February 2010 and supersedes, on 18 November 2010, all previous editions of Annex 13.

For information regarding the applicability of Standards and Recommended Practices, see Chapter 2 and the Foreword.

- **2 Analysis:**

"Analyse, as appropriate, only the information documented in 1. — Factual information and which is relevant to the determination of conclusions and causes and/or contributing factors."

Doc 9756/Part IV - Reporting

BEA

Doc 9756
AN/965

ICAO · OACI · ИКАО

**Manual of
Aircraft Accident
and Incident Investigation**

**Part IV
Reporting**

Approved by the Secretary General
and published under his authority

First Edition — 2003

International Civil Aviation Organization

- Facts should be discussed and analysed in order to determine which events contributed to the accident.

- The analysis part should contain an evaluation of the evidence presented in the factual information part

- The reasoning must be logical and may lead to the formulation of hypotheses which are then discussed

- The discussion in the analysis should support the findings and the immediate and systemic causes of the accident

- The Analysis should look into **systemic** issues
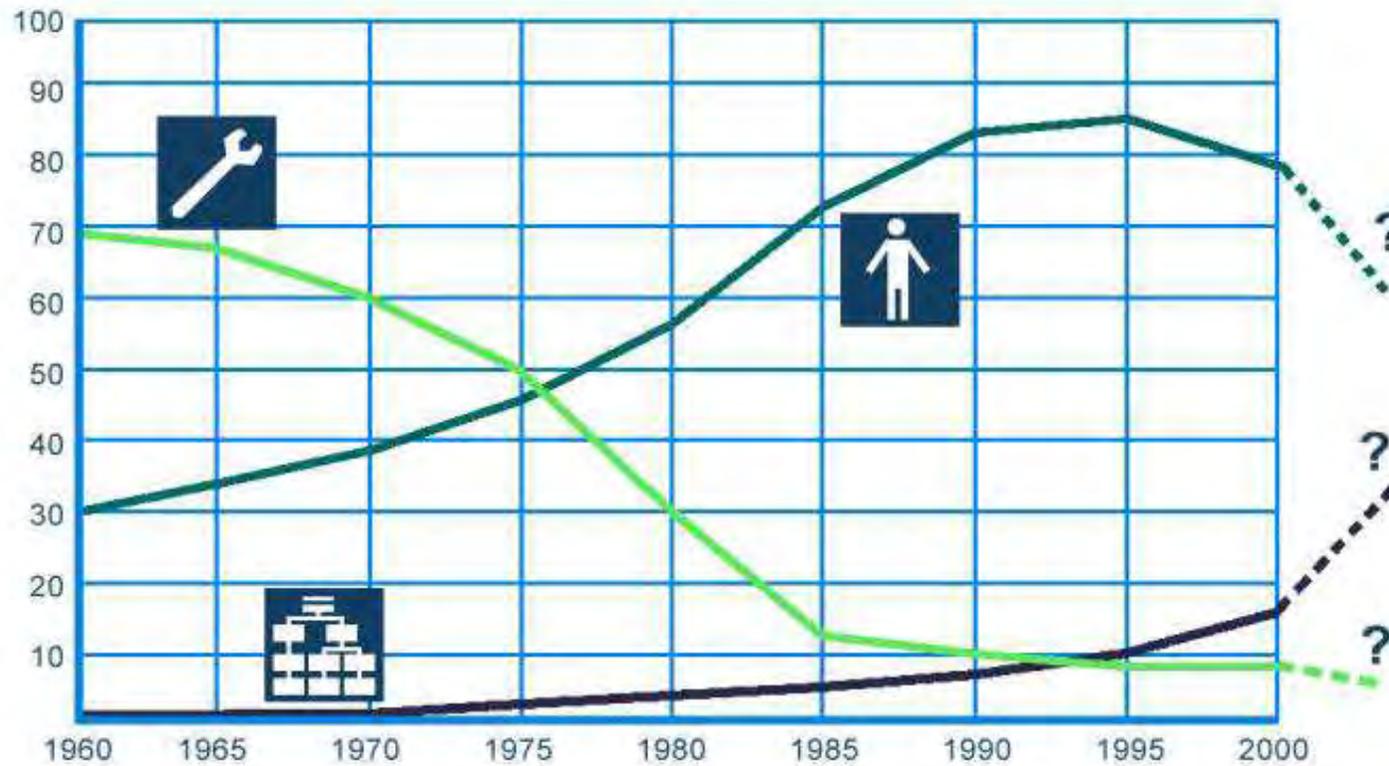
Sources : Erik Hollnagel - Barriers And Accident Prevention 2004

How to build the Analysis?

My Analysis

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General Approach
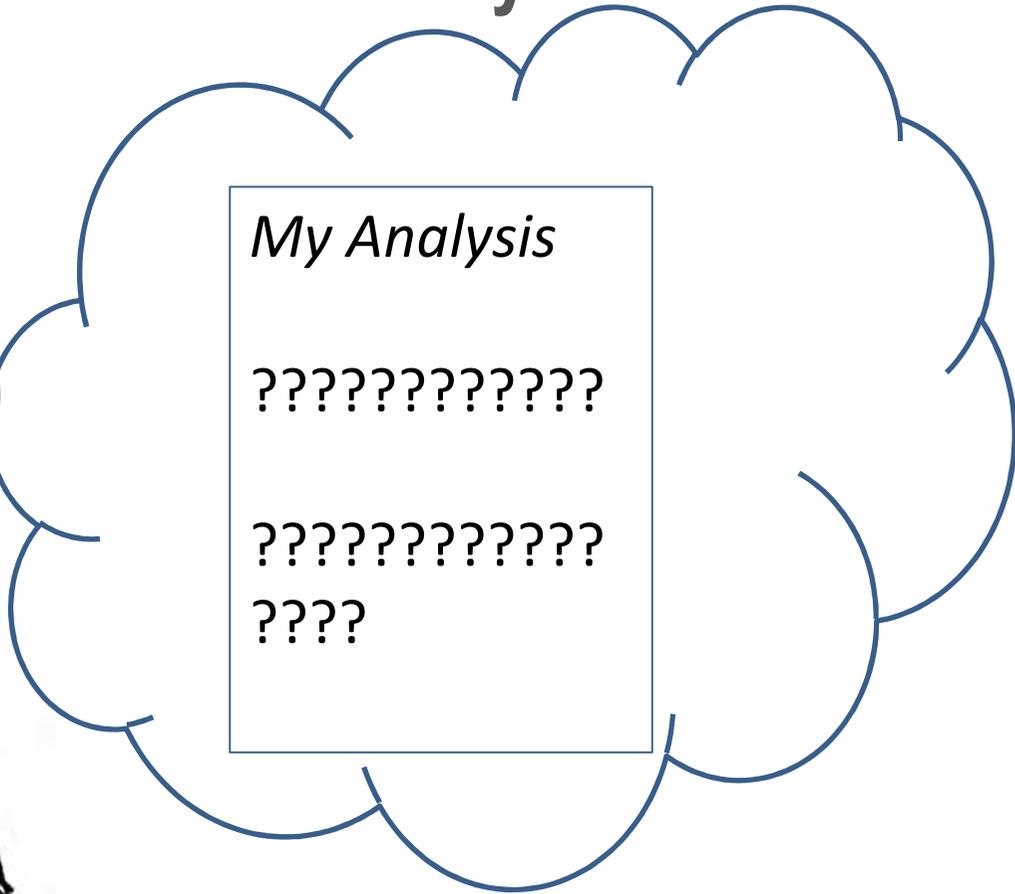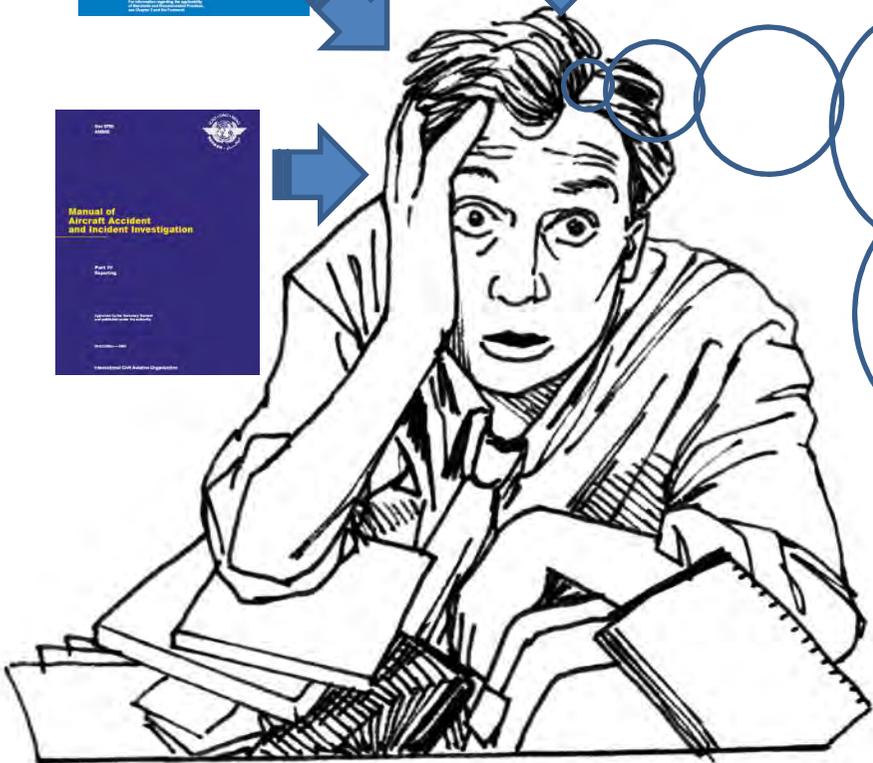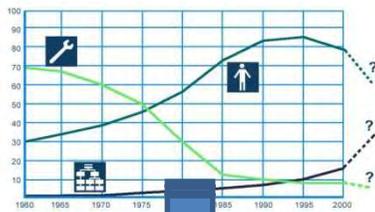
- Based on ideas from Risk management / SMS

Risk Management	Investigation analysis
What are our risks? Are they acceptable? If no, how to mitigate them?	What were the risks in that situation? How were they supposed to be mitigated? What can we learn about the robustness of the measures that were in place?

Accident model

CONTROL

RECOVERY

Loss of Control point
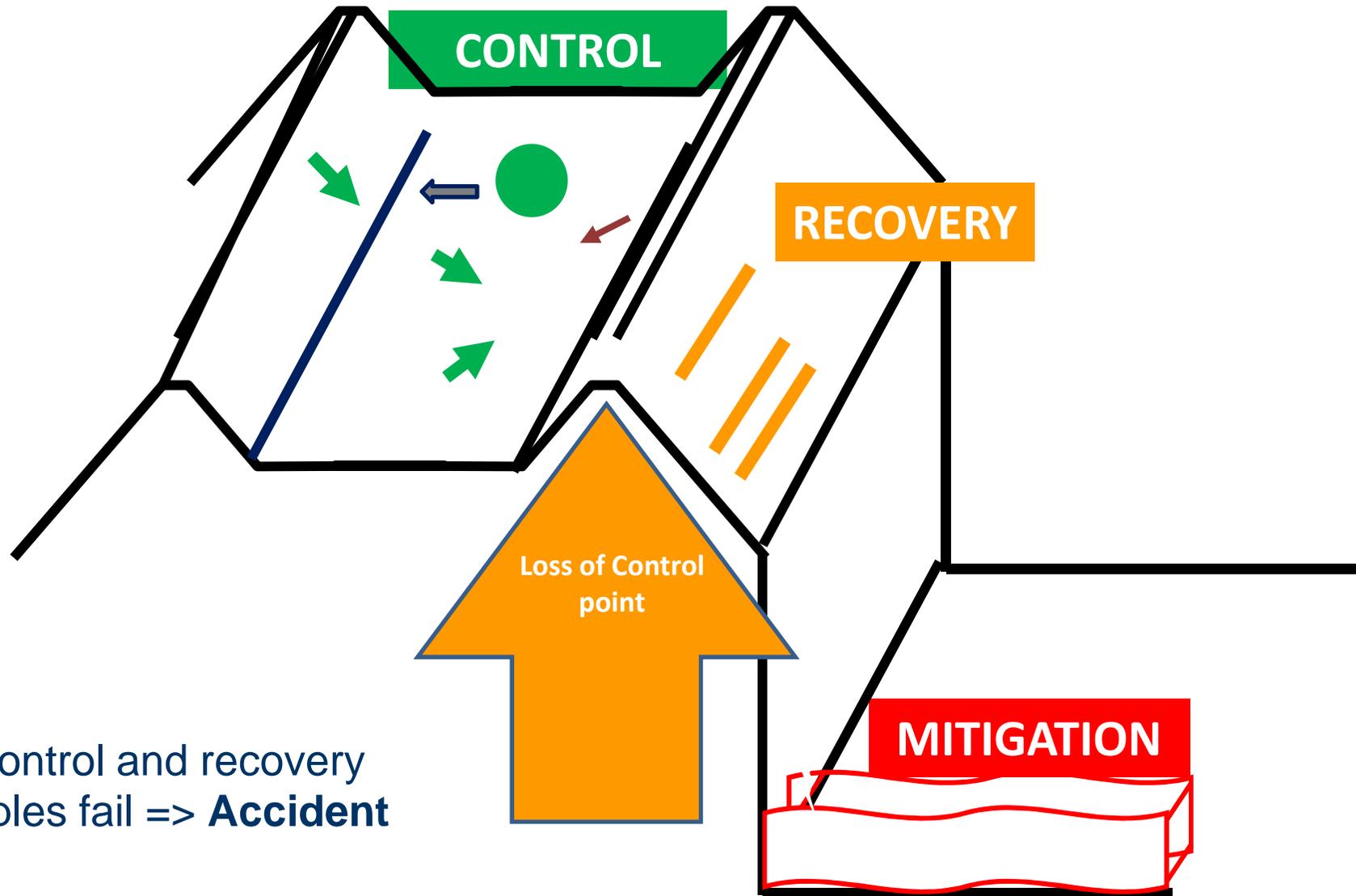
If all control and recovery principles fail => **Accident**

MITIGATION

Safety Principles

BEA

Loss of control point

CONTROL

RECOVERY

Accident
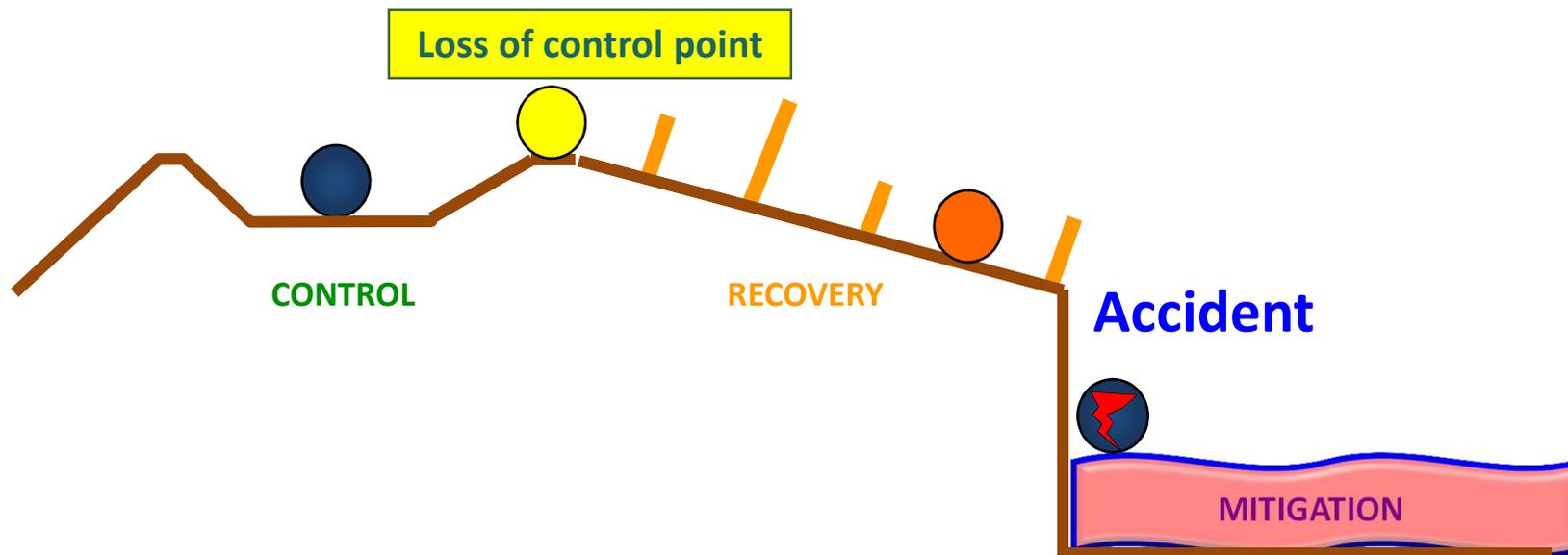
MITIGATION

CONTROL	RECOVERY	MITIGATION
What principles are supposed to keep the situation under control?	What principles are in place to recover from a destabilized situation and prevent the event from developing into an accident ?	What is in place to reduce the consequences of an accident?

Definitions

- Accident
  - ➡ Annex 13 definition
  - ➡ Event that caused damages and that you want to prevent from occurring again in the future
 - ➡ Occurrence categories: LOC-I, CFIT, RE….

- Loss of control point
  - ➡ Start of a sequence that will lead to the accident if no recovery measures are successfully applied
  - ➡ Reached during an Incident, but then it does not go further

| Normal preventive action | Normal preventive action | Emergency action | ... | Emergency action | Emergency action | Accident |

Loss of control Point
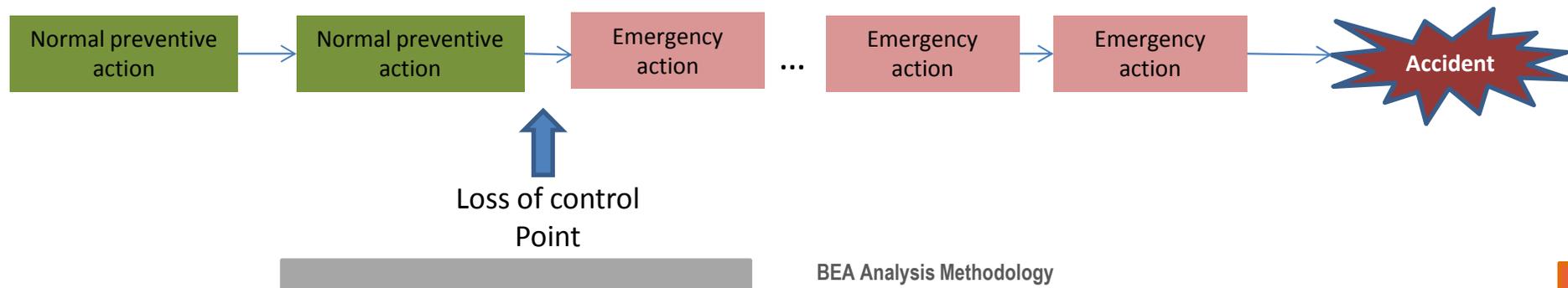
Example: Runway Overrun

Loss of control point = continuation of the final approach with an excessive speed and/or height

CONTROL

RECOVERY

Accident=Runway Overrun

MITIGATION

CONTROL	RECOVERY	MITIGATION
• Adequate landing performance calculations • Stabilized approach • Parameter monitoring • CRM • Missed approach • Braking system OK... • Landing in the TDZ	• The crew detects that the remaining runway length is insufficient • ROPS • Balked landing...	• Obstacle-free environment • EMAS • Safety belts ON • Emergency services available... • Evacuation

The 5 steps of the analysis

- **0** Factual Information
- **1** Define the system
- **2** Define the safety model
- **3** Describe the actual behavior
- **4** Explain the differences
- **5** Draw conclusions on the robustness of the safety model
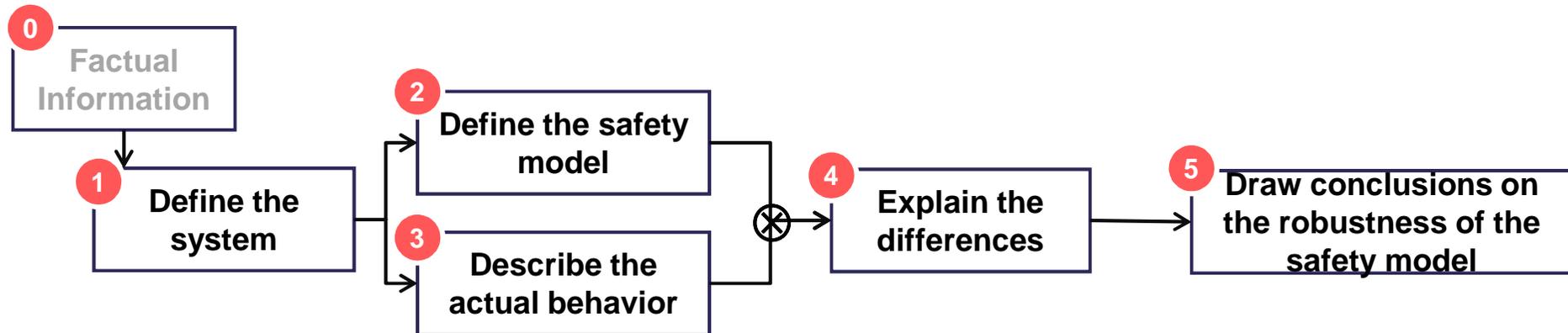
■ Before starting:

➥ Have a solid factual base

➥ Elaborate the first draft of an accident/incident scenario

The 5 steps of the analysis

BEA

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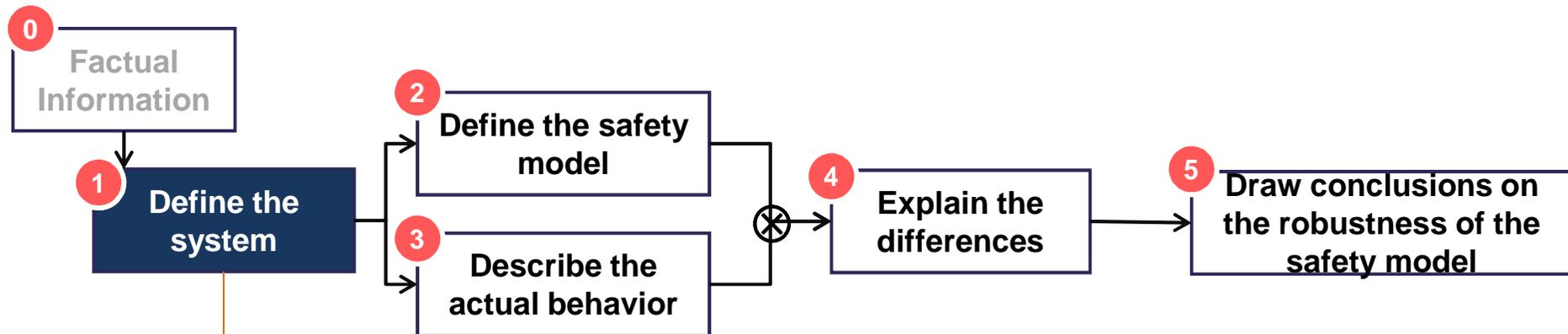
- Identify and define the limits of the system
  - Ex: Aircraft + Crew

- Identify and define the limits of the operational situation
  - Phase of flight
  - Conditions of flight

- Describe the preoccupations of the actors
  - What risks are linked to the operational situation, how are they managed?
  - Personal preoccupations

BEA Analysis Methodology

Hindsight bias

- The inclination to see past events as being more predictable than they actually were; also called the "I-knew-it-all-along" effect.

- The future is **not** known beforehand

Hindsight bias
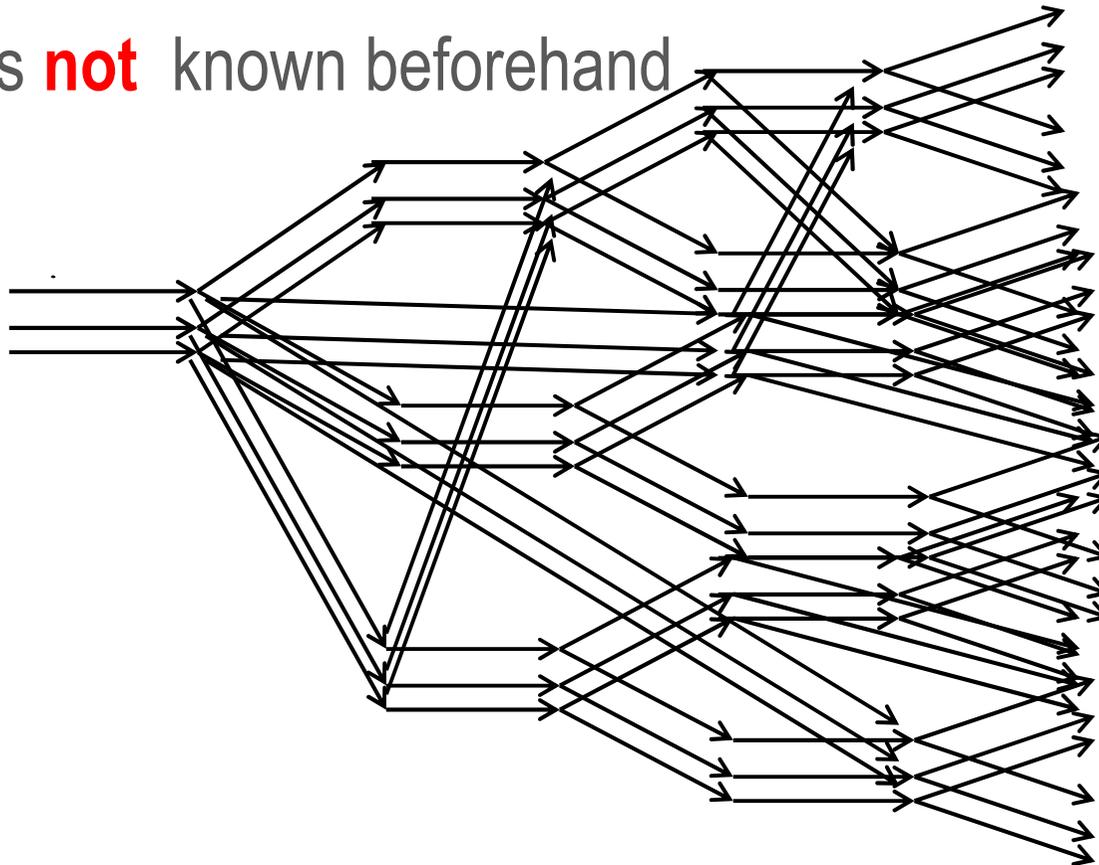
- The past may seem obvious!!

The 5 steps of the analysis

BEA
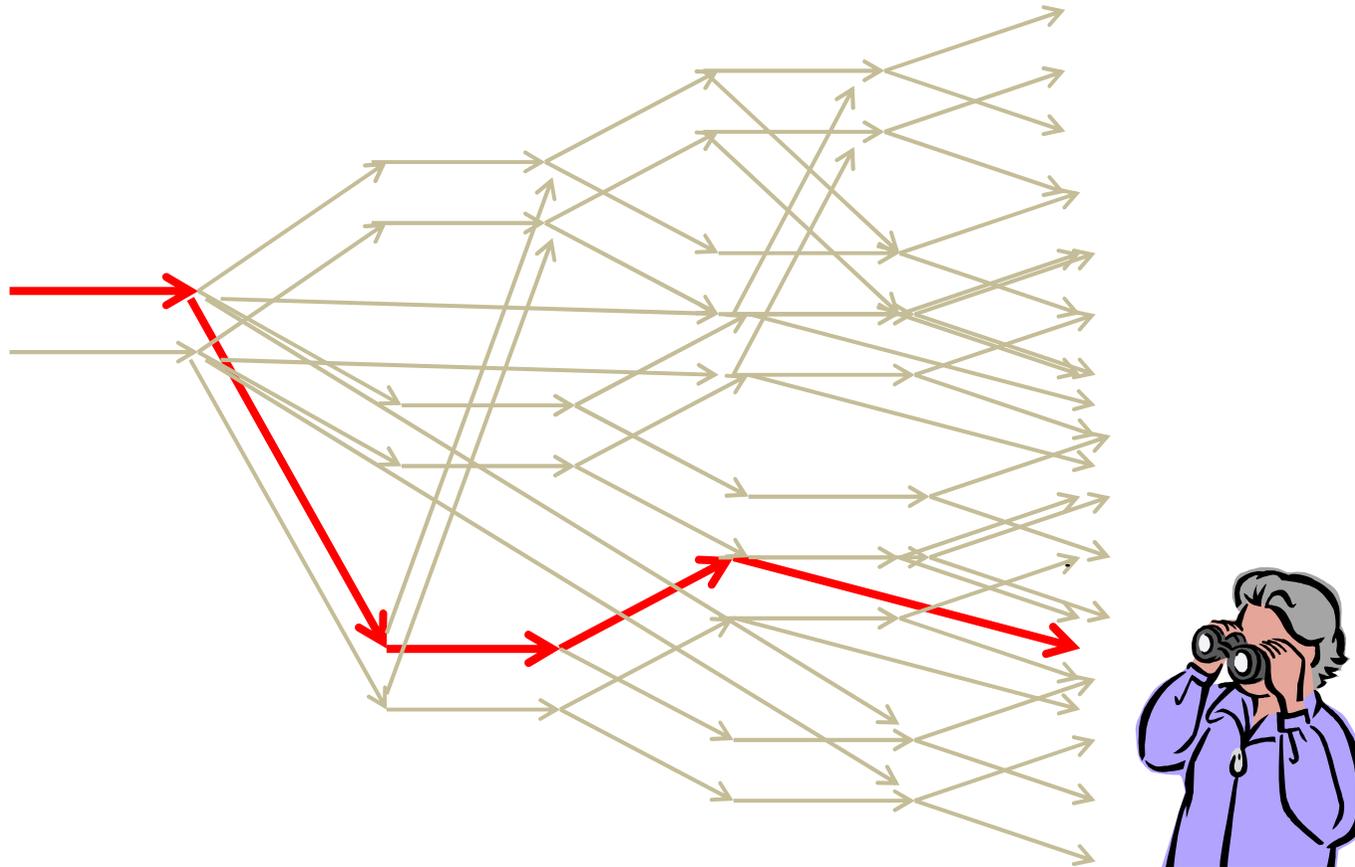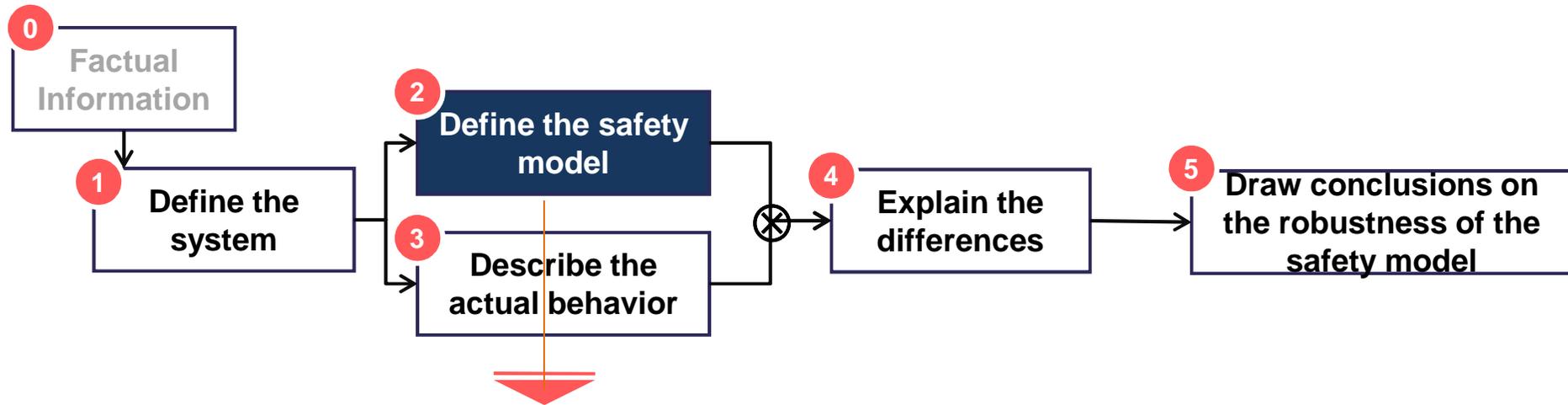
- Apply the accident model to the event in question
  - Determine the accident or the most credible outcome in case of an incident
  - Determine the loss of control point

- Describe the safety principles: Control, Recovery, Mitigation
  - Regulations, Certification requirements
  - Manuals, Procedures
  - Design specifications
  - *Best Practices*
  - *Habits*
  - *Expectations from human performance*

The 5 steps of the analysis

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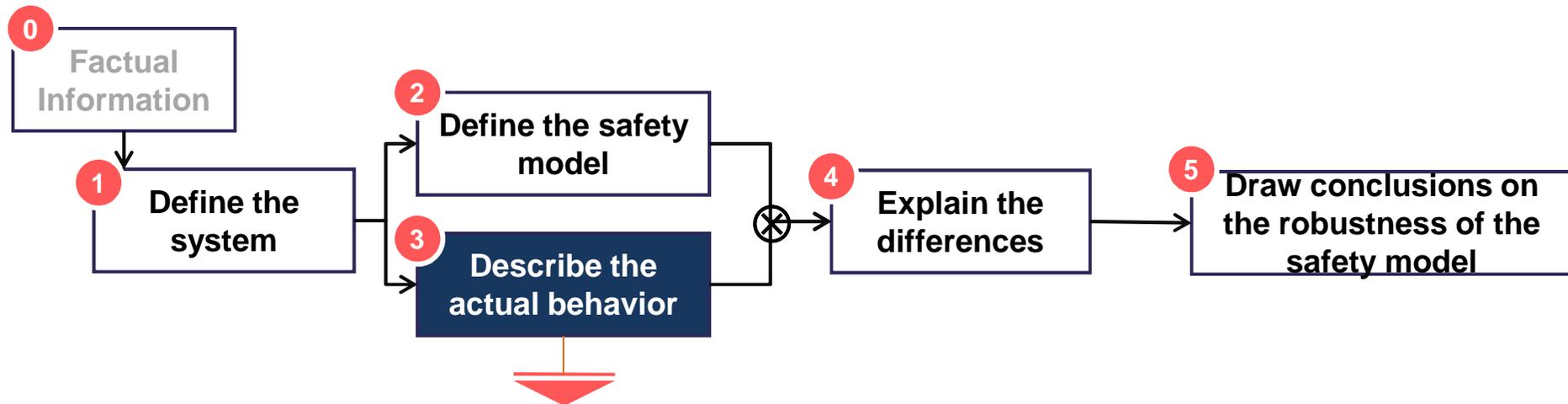
- ■ Build the accident scenario
    - ▪ Assess the effectiveness of the safety principles
    - ▪ The scenario should contain the loss of control point

- ■ Spot the safety principle(s) that **did not** work as planned
    - ▪ Failures
    - ▪ Poor performance of the principle

- ■ Spot the safety principles that **did** work as planned, but
    - ▪ were not sufficient to prevent the accident
    - ▪ were not used during the accident sequence

The 5 steps of the analysis

BEA

```
[0] Factual
    Information
        |
        v
[1] Define the
    system  ---------> [2] Define the safety
                            model
                    \
                     ---> [3] Describe the
                              actual behavior

    [2]+[3] ⊗ ---> [4] Explain the
                        differences  ---> [5] Draw conclusions on
                                              the robustness of the
                                              safety model
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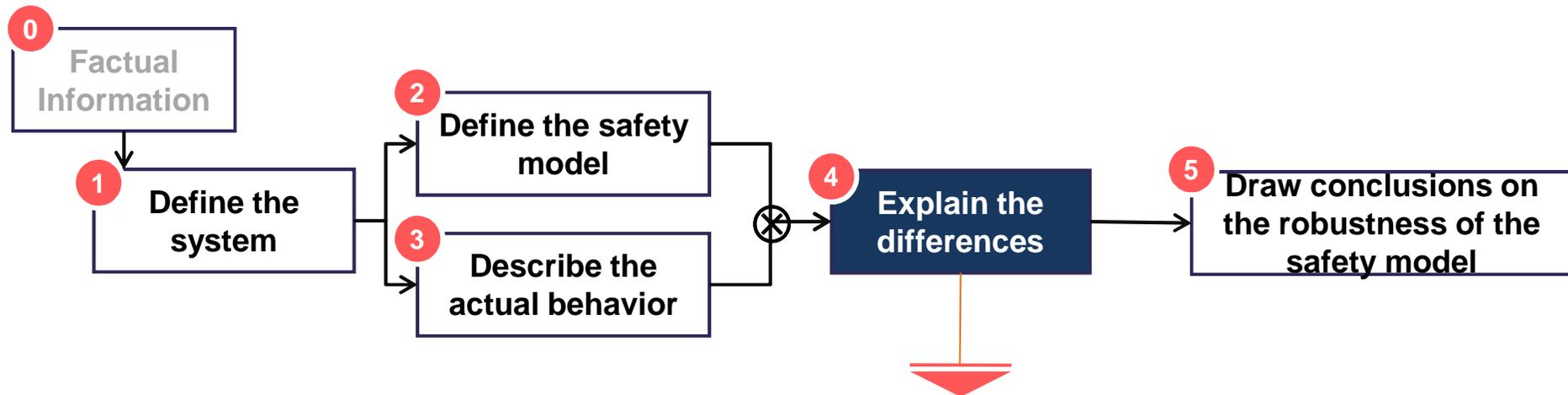
- ■ Understand how human performance could have been affected by the operational context:
  - ▪ SHELL model: interactions of an actor with his/her environment
  - ▪ Do not focus only on deviations from the "norm". Ex: "T*he probable cause of this accident is the failure of the flightcrew to detect and remove ice contamination on the airplane's wings…*"
  - ▪ Explore whether the expectations of the safety model were compatible with "human nature": are they realistic with regards to human capacities, performance, variability and reliability?

- ■ Look at the organization who "owns" the safety principles that did not work as planned:
  - ▪ Constraints
  - ▪ What knowledge did they have when they elaborated the safety principle?

The 5 steps of the analysis

BEA

0 Factual Information

1 Define the system

2 Define the safety model

3 Describe the actual behaviour

⊗

4 Explain the differences

**5** Draw conclusions on the robustness of the safety model
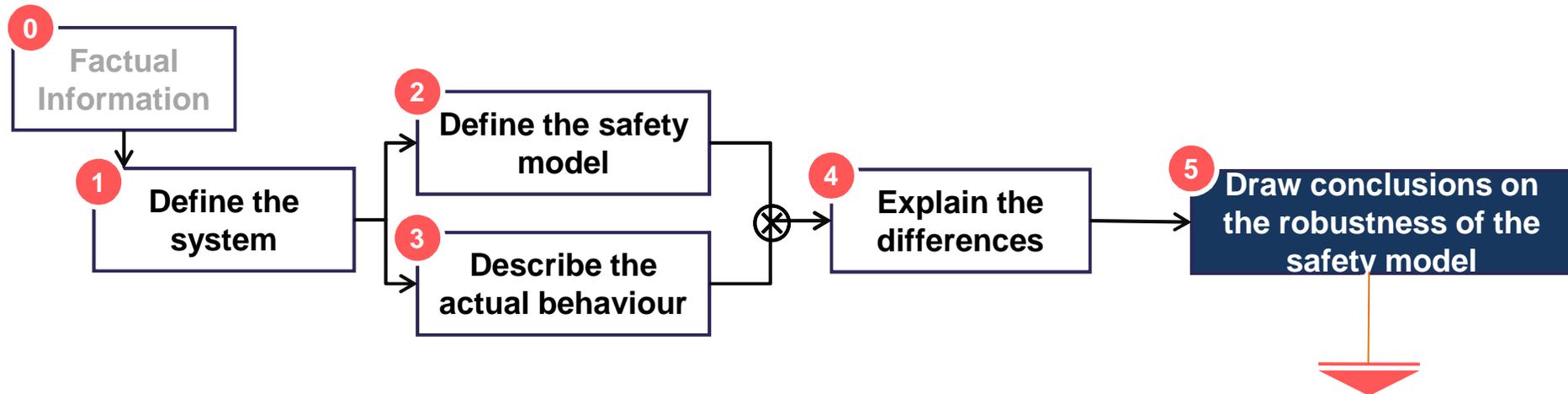
- Look at similar events to determine if the differences (step 4) were already identified earlier
  - Other accident reports, databases (ICAO, Operators, Manufacturers)
  - *but also scientific research, analysis from experts…*
  - Get an idea whether the situation was new, marginal or somehow frequent

- Assess the robustness of the safety principles against the known, predicted or actual
  - contexts
  - technical & human behavior

- If a safety principle worked in most cases and the accident can be considered as isolated, then actions can be recommended to reinforce the selection of personnel, or treat violations…

- Otherwise, recommend to re-adjust the safety principles to better cope with actual behaviors

The 5 steps of the analysis

BEA

```
 0
Factual
Information
    |
    v
 1                    2
Define the     ---->  Define the safety
system                model
    ^          |                        \
    |          |      3                  (x)----> 4              ----> 5
    |          ---->  Describe the            Explain the         Draw conclusions on
    |                 actual behavior         differences         the robustness of the
    |                                                             safety model
    |                                                                    |
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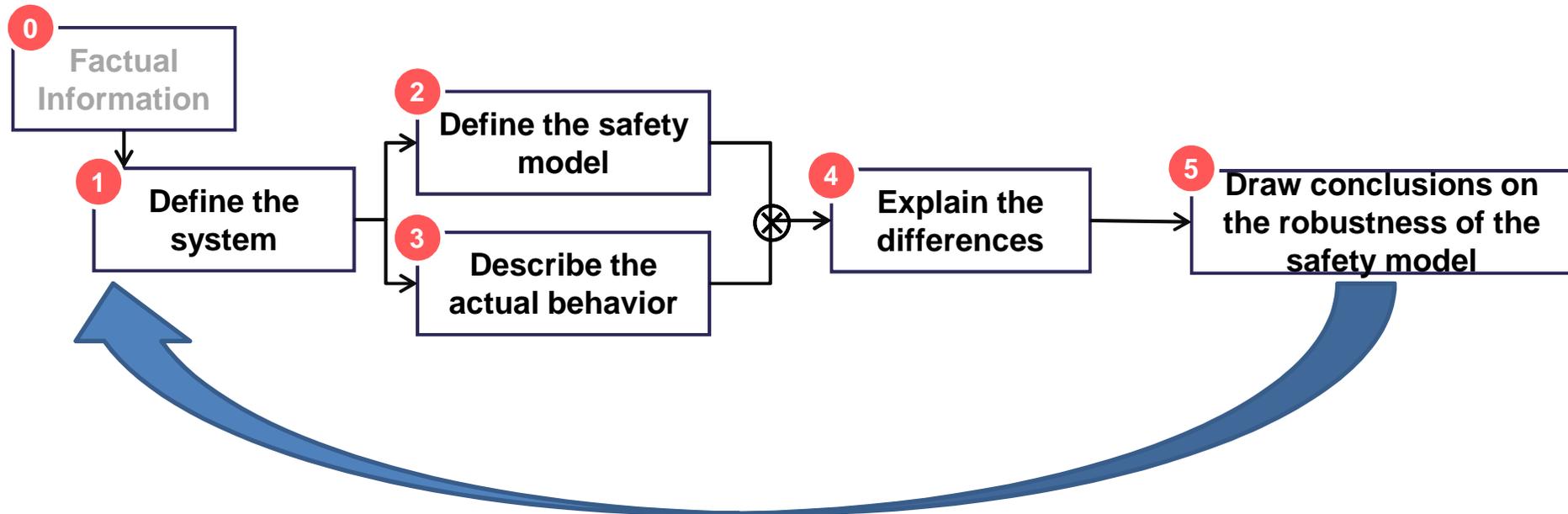
- The analysis is an iterative process
- Work with a team
- Involve Subject Matter Experts

BEA Analysis Methodology

Report Drafting

Example: Runway Overrun

CONTROL	RECOVERY	MITIGATION
• Adequate landing performance calculations • Stabilized approach • Parameter monitoring • CRM • Missed approach • Braking system OK… • Landing in the TDZ	• The crew detects that the remaining runway length is insufficient • ROPS • Balked landing…	• Obstacle-free environment • EMAS • Safety belts ON • Emergency services available… • Evacuation

■ The principles that did not work as planned are the sub-headings of the Analysis part

➥ 2.2 Landing performance calculations

➥ 2.3 CRM

➥ 2.4 Remaining runway awareness

➥ 2.5 Airport obstacle/EMAS

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pour la sécurité de l'aviation civile
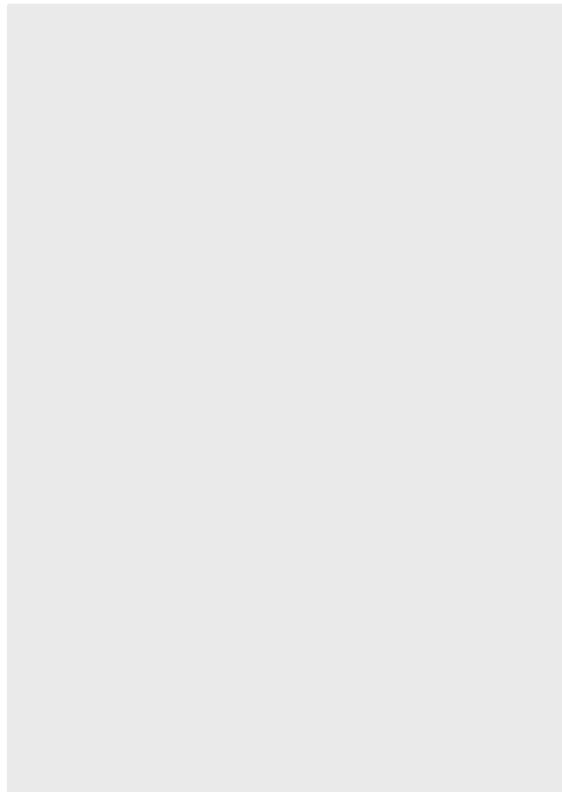
Thank you for your attention

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